



**Request for Qualifications #**      **274-TM-6-25**

**Title:**                                    **Automated Pavement Condition  
Survey - Data Collection**

**Issue Date:**                            **September 16, 2025**

**Due Date:**                                **Friday October 17, 2025 not later  
than 2:00PM EST**

**\*LATE PROPOSALS WILL NOT BE ACCEPTED\***

**Issuing Department:**      ***Raleigh Department of Transportation***

**Direct all inquiries concerning this RFQ to:**

Daniel Callahan

Procurement Analyst

Email: [Daniel.Callahan@raleighnc.gov](mailto:Daniel.Callahan@raleighnc.gov)

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# 1 INTRODUCTION

## 1.1 Purpose

The City of Raleigh is seeking one or more qualified firm(s) with which to contract for the following services:

*The City of Raleigh is seeking qualified applicants/firms to provide automated pavement condition data collection services for the City's ongoing comprehensive pavement management program.*

A detailed scope of services is provided in Section 4 of this document.

All information related to this solicitation, including any addenda, will be posted to the North Carolina electronic Vendor Portal (eVP) at <https://evp.nc.gov/>.

All questions related to this solicitation must be submitted in writing (via email) to the following individual:

Contact Name	Email Address
Daniel Callahan & Benjamin Griffin	<a href="mailto:Daniel.Callahan@raleighnc.gov">Daniel.Callahan@raleighnc.gov</a> / <a href="mailto:Benjamin.Griffin@raleighnc.gov">Benjamin.Griffin@raleighnc.gov</a>

Questions submitted via telephone will not be answered.

## 1.2 Background

The City of Raleigh, the Capital City of North Carolina, remains one of the fastest growing areas in the country. A great economy, top educational institutions, and exceptional health care facilities are some of the characteristics that attract people to the triangle area. The mild climate, diverse work force and proximity to Research Triangle Park combine to make Raleigh a great place to live.

Raleigh is a 21<sup>st</sup> Century City of Innovation focusing on environmental, cultural, and economic sustainability. The City conserves and protects our environmental resources through best practice and cutting-edge conservation and stewardship, land use, infrastructure and building technologies. The City welcomes growth and diversity through policies and programs that will protect and enhance Raleigh's existing neighborhoods, natural amenities, history, and cultural and human resources for future generations. The City leads to improve quality of life for neighborhoods and standard of living for all citizens. The City works with universities, colleges, citizens, and local partners to promote new technology, create new job opportunities, and encourage local businesses and entrepreneurs. The City enlists and prepares 21<sup>st</sup> Century staff with the skill sets to carry out the duties of the City through transparent civic engagement and by providing the very best customer service to our citizens.

*The City of Raleigh is seeking qualified vendors to build on an already strong pavement management program. Automated pavement data collection has been adopted as the standard by City of Raleigh Transportation officials and the City desires to continue cutting edge pavement data collection work to better understand exact conditions and how to better integrate collected data with Agile Assets Pavement Analyst for evaluation.*

### 1.3 **RFQ Timeline**

Provided below is a list of the anticipated schedule of events related to this solicitation. The City of Raleigh reserves the right to modify and/or adjust the following schedule to meet the needs of the project. All times shown are Eastern Time (ET):

<b>RFQ Process</b>	<b>Date and time</b>
RFQ Advertisement Date	<i>September 16, 2025</i>
Pre-Submittal Conference	<i>Tuesday September 23, 2025 (Virtual)</i>
Deadline for written questions	<i>Tuesday September 30, 2025 by 2:00pm EST</i>
City Response to Questions (anticipated)	<i>Friday October 3, 2025</i>
<b>Submittal Due Date and Time</b>	<i>Friday October 17, 2025 by 5:00pm EST</i>
Evaluation Meeting (anticipated)	<i>By Friday October 31, 2025 or earlier</i>
Interviews (if required)	<i>Week of November 10, 2025 (Virtual)</i>
Selection Announcement (tentative)	<i>Week of November 17, 2025</i>

### 1.4 **Pre-Submittal Conference**

In the event that the City of Raleigh elects to conduct a Pre-Submittal Conference or Site Visit, attendance by prospective proposers is mandatory. Prospective Proposers are encouraged to submit written questions in advance. Send all requests for invitation to Benjamin Griffin at [Benjamin.Griffin@raleighnc.gov](mailto:Benjamin.Griffin@raleighnc.gov), and copy [Daniel.Callahan@raleighnc.gov](mailto:Daniel.Callahan@raleighnc.gov).

### 1.5 **Questions**

Requests for clarification and questions to this RFQ must be received by the City not later than the date shown above in Section 1.3 RFQ Timeline, for the submittal of written inquiries. The firm's failure to request clarification and submit questions by the date in the RFQ Timeline above shall be considered to constitute the firm's acceptance of all City's terms and conditions and requirements.

The City shall issue addenda reflecting questions and answers to this RFQ, if any, and shall be posted to North Carolina electronic Vendor Portal ([eVP](#)). No information, instruction or advice provided orally or informally by any City personnel, whether made in response to a question or otherwise in connection with this RFQ, shall be considered authoritative or binding.

Respondents shall be entitled to rely *only* on written material contained in an Addendum to this RFQ.

***It is important that all Respondents submitting to this RFP periodically check [eVP](#) for any Addenda. It is the Respondents responsibility to ensure that all addenda have been reviewed and, if required signed and returned.***

All questions related to this solicitation must be submitted in writing (via email) to the following individual:

Contact Name	Email Address
Daniel Callahan & Benjamin Griffin	<a href="mailto:Daniel.Callahan@raleighnc.gov">Daniel.Callahan@raleighnc.gov</a> / <a href="mailto:Benjamin.Griffin@raleighnc.gov">Benjamin.Griffin@raleighnc.gov</a>

Questions submitted via telephone will not be answered.

**1.6 Submittal Requirements and Contact Information**

Submittals must follow the format as defined in Section 2 Qualifications Package and be addressed and submitted as follows:

<b><u>DELIVERED BY US POSTAL SERVICE MAIL:</u></b>	<b><u>DELIVERED BY OTHER DEIVERY SERVICES:</u></b>
City of Raleigh ATTN: Daniel Callahan 2550 Operations Way Raleigh, NC 27604 RFQ No. 274-TM-6-25	City of Raleigh ATTN: Daniel Callahan 2550 Operations Way Raleigh, NC 27604 RFQ No. 274-TM-6-25

Submittals must be enclosed in a sealed envelope or package and clearly marked with the name of the submitting company, the *RFQ number* and the *RFQ Title*. Proposers must submit:

- A. one (1) signed original;
- B. one (1) electronic version of the signed original;
- C. and (3) copies of the signed proposal.

The electronic version of the Proposal must be submitted as a viewable and printable Adobe Portable Document File (PDF) on a flash drive. Both hard copy and electronic versions must be received by the City on or before the RFQ date and time provided in Section 1.3 RFQ Timeline. Proposals received after the RFQ deadline above will not be considered and will be returned unopened to the return address provided on the submission envelope.

Any requirements in the RFQ that cannot be met must be indicated on Appendix VI: Exceptions to the RFQ and submitted with the qualifications. **Proposers must respond to the entire**

**Request for Qualifications (RFQ).** Any incomplete submittal may be eliminated from competition at the discretion of the City of Raleigh. The City reserves the right to reject any or all submittals for any reason and to waive any informality it deems in its best interest.

Submittals that arrive after the due date and time will not be accepted or considered for any reason whatsoever. If the Firm elects to mail in its response, the Firm must allow sufficient time to ensure the City's proper receipt of the package by the time specified in Section 1.3 RFQ Timeline. Regardless of the delivery method, it is the responsibility of the Firm to ensure that their response arrives at the designated location specified in this Section 1.6 by the due date and time specified in Section 1.3 RFQ Timeline.

### **1.7 MWBE Participation Form**

The City of Raleigh prohibits discrimination in any manner against any person based on actual or perceived age, race, color, creed, national origin, sex, mental or physical disability, sexual orientation, gender identity or expression, familial or marital status, religion, economic status, or veteran status. The City maintains an affirmative policy of fostering, promoting, and conducting business with women and minority owned business enterprises.

Complete and submit the MWBE Participation Form (Appendix IV) with your qualification package.

### **1.8 Rights to Submitted Material**

All qualification packages and supporting materials, as well as correspondences relating to this RFQ, shall become the property of the City. The content of all submittals will be held confidential until the selection of the firm is made. Qualifications will be reviewed by the Evaluation Team, as well as other City staff and members of the general public who submit public record requests. ***Any proprietary data must be clearly marked.*** In submitting qualifications, each submitting firm/company agrees that the City may reveal any trade secret materials contained in such submittal to all City staff and City officials involved in the selection process and to any outside consultant or other third party who serves on the Evaluation Team or who is hired by the City to assist in the selection process. Qualification submittals marked entirely as "confidential", "proprietary", or "trade secret" will be considered non-responsive and will be removed from the evaluation process.

### **1.9 Communications**

All communications of any nature regarding this RFQ with any City staff, elected City officials, evaluation committee members are strictly forbidden from the time the solicitation is publicly posted until award. Questions must be submitted in writing to the individual designated in Section 1.1 Purpose, prior to the deadline provided in Section 1.3 RFQ Timeline. Violation of this provision may result in the firm's proposal being removed from consideration.

### **1.10 Lobbying**

By responding to this solicitation, the firm certifies that it has not and will not pay any person or firm to influence or attempt to influence an officer or employee of the City or the State of North Carolina, or any elected official in connection with obtaining a contract as a result of this RFQ.

### **1.11 Conflicts of Interest**

City of Raleigh contracts are controlled by three conflict of interest provisions.

First, federal procurement standards provide in 2 CFR 200.318 (c)(1),

No employee, officer, or agent may participate in the selection, award, or administration of a contract supported by a Federal award if he or she has a real or apparent conflict of interest. Such a conflict of interest would arise when the employee, officer, or agent, any member of his or her immediate family, his or her partner, or an organization which employs or is about to employ any of the parties indicated herein, has a financial or other interest in or a tangible personal benefit from a firm considered for a contract. The officers, employees, and agents of the non-Federal entity may neither solicit nor accept gratuities, favors, or anything of monetary value from contractors or parties to subcontracts.

Similarly, the North Carolina General Statutes provides a *criminal* statute for conflicts of interest in public contracting, N.C.G.S. § 14-234(a) states:

(1) No public officer or employee who is involved in making or administering a contract on behalf of a public agency may derive a direct benefit from the contract except as provided in this section, or as otherwise allowed by law. (2) A public officer or employee who will derive a direct benefit from a contract with the public agency he or she serves, but who is not involved in making or administering the contract, shall not attempt to influence any other person who is involved in making or administering the contract. (3) No public officer or employee may solicit or receive any gift, favor, reward, service, or promise of reward, including a promise of future employment, in exchange for recommending, influencing, or attempting to influence the award of a contract by the public agency he or she serves.

City of Raleigh Charter Section 3.9 regulates private transactions between the City and its officials and employees. The Charter states:

No member of the City Council, official, or employee of the City of Raleigh shall be financially interested, or have any personal beneficial interest, either directly or indirectly, as agent, representative, or otherwise, in the purchase of, or contract for, or in furnishing any materials, equipment or supplies to the City of Raleigh, nor shall any official or employee of the City of Raleigh accept or receive, or agree to accept or receive, directly or indirectly, from any person, firm or corporation to whom any contract may be awarded or from whom any materials, equipment or supplies may be purchased by the City of Raleigh, by rebate, gift, or otherwise, any money or anything of value whatsoever, or any promise, obligation or contract for future reward or compensation, for recommending or procuring the uses of any such materials, equipment or supplies by the City of Raleigh; no member of the City Council, official or employee of the City of Raleigh shall for his own personal benefit operate, directly or indirectly, any concession in any building or on any lands of the City of Raleigh, nor shall any official or employee of the City of Raleigh bid for or be awarded any contract granting concessionary rights of any nature or kind from the City of Raleigh; it shall be unlawful for any member of the City Council, official or employee of the City of Raleigh to bid for or to purchase or to contract to purchase from the City of Raleigh any real estate, equipment, materials, or supplies of any nature or kind whatsoever, either directly or indirectly, at either public or private sale, either singly, or through or jointly with any other person.

### **1.12 Proposer Expenses**

The City of Raleigh will not be responsible for any expenses incurred by any Firm in the development of a response to this Request for Qualifications or any other activities associated with this procurement including but not limited to any onsite (or otherwise) interviews and/or presentations, and/or supplemental information provided, submitted, or given to City of Raleigh and/or its representatives. Further, the City of Raleigh shall reserve the right to cancel the work described herein prior to issuance and acceptance of any contractual agreement/purchase order by the recommended Firm even if the awarding authority for each entity has formally accepted a recommendation.

### **1.13 Proposer Acceptance**

Submission of any proposal indicates a Proposer's acceptance of the conditions contained in this RFQ unless clearly and specifically noted otherwise on Appendix VI Exceptions to RFQ and submitted with proposal. The City of Raleigh has the sole discretion and reserves the right to cancel this RFQ, and to reject any and all proposals, to waive any and all informalities and/or irregularities, if it is deemed to be in the City of Raleigh's best interests to do so. The City of Raleigh reserves the right to accept or reject any or all of the items in the proposal, and to award the contract in whole or in part and/or negotiate any or all items with individual Firms if it is deemed in the City of Raleigh's best interest. Moreover, the City of Raleigh reserves the right to make no selection if proposals are deemed not in the best interest of the City of Raleigh.

## **2 QUALIFICATIONS PACKAGE**

Submittal responses must follow the format outlined below. The City may reject as non-responsive at its sole discretion any submittal that does not provide complete and/or adequate responses or departs in any substantial way from the required format.

### **2.1 Request for Qualifications Required Document Format**

Responses should be divided using tabs to separate each section, listed sequentially as follows:

#### **Tab 1: Cover Letter**

Provide an introduction letter summarizing the unique qualifications of your firm to meet the needs of this project. This letter should be presented on the firm's official letterhead and signed by an authorized representative who has the authority to enter into a contract with the City on behalf of the firm. Include the name, address, telephone and email address of the individual who serves as the point of contact for this solicitation.

#### **Tab 2: Corporate Background and Experience**

Include background information on the firm and provide detailed information regarding the firm's experience with similar projects. Provide a list of all similar contracts performed in the past 5 years, accompanied by corresponding references (contact persons, firm, telephone number and email address).

Include the total amount invoiced for each listed project, the length of the project, and list of personnel involved in the project who are also proposed for the subject project named in this solicitation. Failure to provide a list of all similar contracts in the specified period may result in the rejection of the firm's proposal. The evaluation team reserves the right to contact any or all listed references, and to contact other public entities regarding past performance on similar projects.

**Tab 3: Financial Information**

Review and provide one of the following three (3) financial statement options:

1. Recent audited or reviewed financial statements prepared by an independent certified public accountant (CPA) that shall include, at a minimum, a balance sheet, income statement (i.e., profit/loss statement) and cash flow statement **and**, if the audited or reviewed financial statements were prepared more than six (6) months prior to the issuance of this RFQ, the Proposer shall submit its most recent internal financial statements (balance sheet, income statement and cash flow statement or budget with entries reflecting revenues and expenditures from the date of the audited or reviewed financial statements to the end of the most recent financial reporting period (i.e., the quarter or month preceding the issuance date of this RFQ)).

OR

2. Recent compiled financial statements prepared by an independent CPA that shall include, at a minimum, a balance sheet, income statement (i.e., profit/loss statement) and cash flow statement **and**, if the compiled financial statements were prepared more than three (3) months prior to the issuance of this RFQ, the Proposer shall submit its most recent internal financial statements (balance sheet, income statement and cash flow statement or budget with entries reflecting revenues and expenditures to date), and other evidence of financial stability such as most recently filed income tax return, evidence of a line of credit/loans/other type of financing with statement of amount in use/outstanding balance (e.g., a complete copy commitment letter, loan agreement, billing statement reflecting the line of credit or statement from lender acknowledging the commitment to fund the Proposer's stated financing), personal guaranty with copies of personal income tax filing and statement of net worth or such other evidence that is accurate, reliable and trustworthy regarding the Proposer's financial stability.

OR

3. Include a certified, signed statement from a licensed CPA regularly engaged in the review of the firm's financial information verifying the financial viability of the firm.

All financial information, statements and/or documents provided in response to this solicitation shall be kept confidential provided that EACH PAGE is marked as follows: "CONFIDENTIAL – DO NOT DISCLOSE EXCEPT FOR THE EXPRESS PURPOSE OF PROPOSAL EVALUATION."

**“Recent”** shall be defined as financial statements that were prepared within the 12 months preceding the issuance date of this RFQ.

**Consolidated financial statements** of the Proposer’s parent or related corporation/business entity will not be considered, unless: (1) the Proposer’s actual financial performance for the designated period is separately identified in and/or attached to the consolidated statements; (2) the parent or related corporation/business entity provides the State with a document wherein the parent or related corporation/business entity will be financially responsible for the Proposer’s performance of the contract and the consolidated statement demonstrates the parent or related corporation’s/business entity’s financial ability to perform the contract, financial stability and/or such other financial considerations identified in the evaluation criteria; and/or (3) Proposer provides its own internally prepared financial statements and such other evidence of its own financial stability identified above.

The firm’s failure to provide any of the above-referenced financial statements may result in the proposal being removed from consideration. Proposers are also encouraged to explain any negative financial information, and to provide documentation supporting those explanations and demonstrating the financial strength of the firm.

**Tab 4: Project Understanding, Approach and Schedule**

Provide a comprehensive narrative, outline, and/or graph demonstrating the firm's understanding and approach to accomplishing the tasks outlined in the Scope of Work section of this RFQ. A description of each task and deliverable and the schedule for accomplishing each shall be included.

**Tab 5: Team Firm, Experience and Certifications/Qualifications**

This section must include the proposed staffing, deployment and firm of personnel to be assigned to this project. The Proposer shall provide information as to the qualifications and experience of all executive, managerial, legal, and professional personnel to be assigned to this project, including resumes citing experience with similar projects and the responsibilities to be assigned to each person. A project-specific firm chart which clearly illustrates the roles, responsibilities, and the reporting relationships of each team member should be included.

**2.2 Hourly Rates**

This solicitation is being issued in accordance with NCGS 143-64.31, otherwise known as the Mini-Brooks Act, and therefore price cannot and will not be a determining factor in the selection of the successful contractor. One copy of the Hourly Rate Schedule (see Appendix I) for all proposed project personnel should be enclosed in a separate, sealed envelope.

**2.3 Qualifications Package Documents**

This RFQ is comprised of the base RFQ document, any attachments, and any addenda released before Contract award. All attachments and addenda released for this RFQ in advance of any Contract award are incorporated herein by reference.

### 3 PROPOSAL EVALUATION

#### 3.1 Evaluation Criteria

This is not a bid. There will not be a public opening. Submittals will be evaluated based solely on the following criteria:

Criteria	(a) Weight	(b) Score (0-3)	(a) x (b) Weighted Score
Corporate Background and Experience	10		
Firm Financial Stability	15		
Project Understanding	25		
Project Approach	25		
Team Firm, Experience, and Qualifications	25		
<b>Final Score</b>			

#### Score Points

0 - Missing or Does Not Meet  
Expectation

1 - Partially Meets Expectation

2 - Meets Expectation

3 - Exceeds Expectation

#### 3.2 Final Selection

Qualifications will be reviewed after opening and will be ranked in order of choice, at which point contract negotiations will begin with the most qualified firm. If negotiations are unsuccessful, the City will then pursue negotiations with the next most qualified firm.

The City shall not be bound or in any way obligated until both parties have executed a contract. The City also reserves the right to delay the award of a contract or to not award a contract.

The terms and conditions and specifications of the RFQ, including the firm's fee proposal, and/or written correspondence applicable to the RFQ, may become part of the contract documents. Failure of the awarded firm to perform as represented may result in contract cancellation.

#### 3.3 Notice to Submitting Firms Regarding RFQ Terms and Conditions

It shall be the Submitting Firm's responsibility to read the Instructions, the City's terms and conditions, all relevant exhibits and attachments, and any other components made a part of this RFQ, and to comply with all requirements and specifications provided herein. Submitters are responsible for obtaining and complying with all Addenda and other changes that may be issued in connection with this RFQ.

### **3.4 Contract Term**

The Contract shall be effective on the date the Contract is signed by the City (the “Effective Date”) and will state a Completion Date for the work to be completed by the firm selected and awarded the contract.

Initial contract term will be no less than 3 years, with two optional one-year renewals.

## **4 SCOPE OF SERVICES**

Awarded firm shall provide services, all as set forth in this RFQ and more particularly described in this Section 4.

Awarded Contractor shall provide services, including the following:

- Initial calibration verification;
- Automated data collection of pavement distress data and optional inventory data from ROW video;
- Data quality management;

The proposer shall provide a Work Plan to show how the proposer plans to accomplish the work relative to methodology, tools, personnel, phasing etc. The Work Plan should provide a Gantt chart indicating the different tasks that the Proposer anticipates undertaking with the approximate start and end dates relative to the Notice to Proceed.

The Proposer should also include information on the Proposer’s standard quality management (including Proposer’s sample Quality Management Plan) and how this meets the quality requirements given in the Quality Management section below.

### **4.1 Overview**

The survey is required to be performed using a profiler and/or an automated 3D Laser Crack Measurement System (LCMS) of all local roads in the City. The data items to be collected include all items listed in the City of Raleigh Data Dictionary in Appendix V. In addition, the data collection shall include high resolution, digital images of the pavement right of way taken at increments of 20 feet or less.

The City’s preference is that the data collection will start in March 2026 and finish no later than August 2026.

### **4.2 Network Scope Definition and Frequency**

The total mileage to be surveyed is approximately 1160 miles. All miles will be surveyed in one direction only, in the direction given by the begin and end descriptions in the data file supplied with this solicitation.

The data collection will be required on the above mileage in years 1, 3 and 5. The pricing for this scope should assume the above quantity but the cost proposal shall be stated in terms of cost per mile. The final mileage delivered will be used for payment.

### **4.3 Location Referencing**

The City will provide the selected Proposer with a GIS shape file or geodatabase that includes all road segments to be surveyed.

All survey data collected will be required to be delivered in tabular data format, with the GIS ID included (so that it can be related back to the GIS information), summarized in approximately 6 ft increments, with start points located by Latitude and Longitude coordinates which shall be stated in WGS84 coordinate systems. All location attributes are to be captured according to the City of Raleigh Data Dictionary included in Appendix VIII.

### **4.4 Specifications**

Proposers should describe how they meet the following specifications for methodology and equipment in their proposal.

#### **4.4.1 Survey Data**

All data shall be collected in outside through lanes. Exceptions to this should be noted in the Comments field. Proposers should describe in their proposal how exceptions and possible bad data will be flagged. Included in this flagged list shall, at a minimum, be indicators of

- bridges,
- railway crossings and
- construction zones.

Data shall be collected for the items and in the format specified in the Data Dictionary in Appendix VIII.

Data shall be collected according to the Data Quality Management Plan (DQMP) in Appendix VII. This includes specific protocols required for equipment and methods of collecting the data.

### **4.5 Equipment**

#### **4.5.1 General**

- The proposer shall use a fully integrated system designed to collect all data in a single pass by synchronizing all data to a single point of reference in the field (with no post processing).

#### **4.5.2 Digital Laser Profiler (also applies if collecting roughness using LCMS)**

- Must meet the standards for roughness collection specified in the Data Quality Management Plan (DQMP) in Appendix VII.

#### **4.5.3 3D Laser Crack Measurement System (LCMS)**

- Must be capable of collecting Rutting (full transverse pavement measurement covering a pavement width of 12 ft), 3D surface profile, pavement roughness, automated crack detection classification and categorization, and automated pothole classification. All measurements (including if LCMS used for collection of roughness) shall meet the standards specified in the Data Quality Management Plan (DQMP) in Appendix VII.

#### **4.5.4 Location Measurement**

- Differential global positioning system (sub meter accuracy) backed up by inertial system in case of loss of GPS.
- High accuracy Distance Measuring Instrument (DMI).

#### **4.5.5 Digital Imaging System**

- All cameras must be calibrated for scale measurement to allow visible assets to be referenced geospatially from the images now or in the future.
- High-resolution roof-mounted digital cameras for asset extraction.
- Imagery to be integrated with pavement data using the same geo-location system.

#### **4.5.6 Integrated Viewing Software**

- Software access to view and export survey data, including synchronized pavement and ROW imagery through a data viewer application that allows users to navigate through collected data and view the distresses on the road surface, individual images, as well as summarized data and output graphs.
- The software should allow the user to specify the location to be viewed.
- Data must be hosted externally with no need to install software.
- The proposal should include any software license costs for the term of the contract with the option to extend.

#### **4.5.7 Postprocessing**

- Recorded information must have the necessary resolution and accuracy to allow postprocessing to extract additional inventory or condition data at a later date.

### **4.6 Quality Management**

- Both quality control (QC) and quality assurance (QA) are important to ensure collected pavement condition data is accurate and repeatable. The Proposer will be responsible for QC and QA of the data and will be required to deliver an initial calibration verification report according to the Data Quality Management Plan (DQMP) in Appendix VII prior to being allowed to proceed with the main data collection in each collection year. Proposers should include a sample Quality Management Plan with their proposal. Explicitly, in the approach description, the vendor should explain how they intend to minimize the effects of the vehicle wander (where the vehicle does not follow the same path every time) and DMI drift by ensuring images are segmented the same across runs both longitudinally and transversely during initial calibration and calibration verification runs.
- Data shall be collected in accordance with the Data Quality Management Plan (DQMP) in Appendix VII.

- Possible bad data shall be flagged.

## 4.7 Deliverables

### 4.7.1 Data

- The following data deliverables are expected:
  - Vendor Quality Management Plan: all quality assurance and quality control processes and procedures that the vendor warrants will be undertaken during the project.
  - Vendor Startup Report: Report showing Accuracy and Repeatability specifications have been met based on the Data Quality Management Plan (DQMP) in Appendix VII.
  - Initial Data Collection Segment dataset: Initial delivery of survey data of first 100 data collection segments (approximately 6 ft segments) in the format specified in the Data Dictionary in Appendix VIII.
  - Data Collection Segment dataset: Final delivery of survey data in the format specified in the Data Dictionary in Appendix VIII.
  - Final delivery of QC results showing any flagged possible data problems.

### 4.7.2 Imagery and Viewing Software

- In addition to the data delivery, the following deliverables regarding imagery and viewing software are expected:
  - Software access to view and export survey imagery data, both downward range and intensity data from the LCMS, and ROW imagery data, based on specifications. Software access should be provided for the duration of the contract. Proposer should provide licensing terms for all software.
  - If detailed downward pavement imagery data, and ROW imagery are not exportable from the software, imagery should be able to be delivered on one or more hard-drives for possible later use.

## 4.8 Optional Items

### 4.8.1 Data Collection Segment dataset

The following items are optional items to be collected by downward imaging and delivered as additional attributes with the Data Collection Segment dataset. Proposer will submit the cost per mile for these items and describe the attributes that will be collected for the indicated cost.

Data Collection Items

Item	Suggested Attributes
Pavement Markings	Number
Pavement Striping	Total length per type
Pavement Striping	Presence or absence (left, right, center)
Pavement Markings/ Striping	Retro reflectivity or some other condition information

The following items are optional items to be collected and delivered as additional attributes with the Data Collection Segment dataset. Proposer will submit the cost per mile for these items and describe the attributes that will be collected for the indicated cost.

#### Data Collection Items

Item	Suggested Attributes
Curb Left	Yes/No
Curb Right	Yes/No
Pavement Width	Feet

#### 4.8.2 GIS layer information

The following items are optional items to be collected by right of way imaging. Proposer will submit the cost per mile for these items and describe the attributes that will be collected for the indicated cost. GIS items should be delivered as GIS layers: point features and line features in different layers.

#### GIS Line Features

Item	Suggested Attributes
Guardrail	Street, GIS_ID, Begin DFO*, Begin Lat/Long, End DFO, End Lat/Long, Left/Right
Fence	Street, GIS_ID, Begin DFO*, Begin Lat/Long, End DFO, End Lat/Long, Left/Right, Avg. Height
Medians/Monolithic Islands	Street, GIS_ID, Begin DFO*, Begin Lat/Long, End DFO, End Lat/Long, Left/Right

\*Distance from Origin

**APPENDIX I**

**HOURLY RATE SCHEDULE**

Awarded firm shall perform the services to be performed as set forth in this RFQ and more particularly described in Section 4 Scope of Services utilizing the following hourly rate schedule below.

As stated above in section 2.2 Hourly Rates, provide the Hourly Rate Schedule in a separate, sealed envelope.

Position Title	Hourly Rate

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Firm Name: \_\_\_\_\_

Authorized Signature: \_\_\_\_\_ Date \_\_\_\_\_

Signed by: \_\_\_\_\_  
[Type or Print Name]

Title of Signer: \_\_\_\_\_

## APPENDIX II PROPOSER QUESTIONNAIRE

The following questions must be answered, and data given must be clear and comprehensive. If necessary, questions may be answered on separate sheets. The Proposer may submit any additional information desired.

Company Name:		d/b/a (if applicable)	
Street / PO Box:			
City:		State:	Zip:
Phone:	Fax:	E-Mail:	
Website (if applicable):			
<input type="checkbox"/> Sole Proprietor <input type="checkbox"/> Partnership <input type="checkbox"/> Corporation <input type="checkbox"/> Other			
Number of years in business under company's present name:			
Fed Tax ID #:		DUNS #	
Are you registered with the North Carolina Secretary of State to conduct business (if required)? (Check One) YES: <input type="checkbox"/> NO: <input type="checkbox"/> Not Applicable: <input type="checkbox"/>			
Are you properly licensed/certified by the Federal and/or State of North Carolina to perform the specified work? YES: <input type="checkbox"/> NO: <input type="checkbox"/> Not Applicable: <input type="checkbox"/> ATTACH COPY OF ALL APPLICABLE LICENSING/CERTIFICATION DOCUMENTS			
Are/will you be properly insured to perform the work? YES: <input type="checkbox"/> NO: <input type="checkbox"/>			
Contact for this Contract:		Title:	
Phone:	Fax:	E-Mail:	
Have you ever defaulted or failed on a contract? (If yes, attach details) YES: <input type="checkbox"/> NO: <input type="checkbox"/>			
List at least three (3) references for which you have provided these services (same scope/size) in the past three years - preferably government agencies. Do not include City of Raleigh as a reference to meet the requirement of listing at least (3) references. <b>PROPOSERS ARE RESPONSIBLE FOR SENDING REFERENCE QUESTIONNAIRE (APPENDIX III) TO THEIR REFERENCES.</b>			
1.	Company:		
Contact Person:		Title:	
Phone:	Fax:	E-Mail:	
Describe Scope of Work:			
2.	Company:		
Contact Person:		Title:	
Phone:	Fax:	E-Mail:	
Describe Scope of Work:			
3.	Company:		
Contact Person:		Title:	
Phone:	Fax:	E-Mail:	
Describe Scope of Work:			
4.	Company:		
Contact Person:		Title:	
Phone:	Fax:	E-Mail:	
Describe Scope of Work:			
5.	Company:		
Contact Person:		Title:	
Phone:	Fax:	E-Mail:	
Describe Scope of Work:			
The undersigned swears to the truth and accuracy of all statements and answers contained herein:			
Authorized Signature:		Date:	

## **APPENDIX III**

### **REFERENCE QUESTIONNAIRE (Instructions)**

#### ***274-TM-6-25***

The City of Raleigh, as a part of the RFQ, requires proposing companies to submit a minimum of three (3) business references as required within this document. The purpose of the references is to document the experience of the proposer relevant to the scope of services and assist in the evaluation process.

- The Proposer is required to send the reference form (the following two pages) to each business reference listed on Proposer Questionnaire.
- The business reference, in turn, is requested to submit the Reference Form directly to the City of Raleigh Point of Contact identified on the Reference Questionnaire form for inclusion in the evaluation process.
- The form and information provided will become a part of the submitted proposal. The business reference may be contacted for validation of the response.
- It is the Proposer's responsibility to verify their references have been received by the City of Raleigh Point of Contact by the date indicated on the reference form.

**APPENDIX III**

**REFERENCE QUESTIONNAIRE FORM**

**274-TM-6-25**

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**(Name of Business Requesting Reference)**

This form is being submitted to your company for completion as a business reference for the company listed above.

This form is to be returned to the City of Raleigh, **Daniel Callahan** via email to **Daniel.Callahan@raleighnc.gov** no later than **proposal due date** and **MUST NOT** be returned to the company requesting the reference.

For questions or concerns regarding this form, please contact the City of Raleigh, Point of Contact above.

**Company Providing Reference**

**Contact Name and Title/Position**

**Contact Telephone Number**

**Contact Email Address**

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Questions:

1. In what capacity have you worked with this company in the past? If the company was under a contract, please acknowledge and explain briefly whether or not the contract was successful.

Comments:

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2. How would you rate this company's knowledge and expertise?

3= Excellent     2= Satisfactory     1= Unsatisfactory     0= Unacceptable

Comments:

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3. How would you rate the company's flexibility relative to changes in the scope and timelines?

3= Excellent     2= Satisfactory     1= Unsatisfactory     0= Unacceptable

Comments:

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4. What is your level of satisfaction with hard-copy materials, e.g. reports, logs, etc. produced by the company?  
 3= Excellent       2= Satisfactory       1= Unsatisfactory       0= Unacceptable

Comments:

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5. How would you rate the dynamics/interaction between the company and your staff?  
 3= Excellent       2= Satisfactory       1= Unsatisfactory       0= Unacceptable

Comments:

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6. Who were the company's principle representatives involved in providing your service and how would you rate them individually? Would you comment on the skills, knowledge, behaviors or other factors on which you based the rating?  
(3= Excellent; 2= Satisfactory; 1= Unsatisfactory; 0= Unacceptable)

Name: _____	Rating: _____
Name: _____	Rating: _____
Name: _____	Rating: _____
Name: _____	Rating: _____

Comments:

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7. With which aspect(s) of this company's services are you most satisfied?

Comments:

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8. With which aspect(s) of this company's services are you least satisfied?

Comments:

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9. Would you recommend this company's services to your organization again?

Comments:

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# APPENDIX IV

## MWBE PARTICIPATION FORM

### IDENTIFICATION OF MWBE PARTICIPATION FOR PROFESSIONAL SERVICES

This Identification of MWBE Participation Form captures information regarding MWBE participation in the providing of professional services as defined by NCGS §143-64.31, *et seq.* MWBE participation is encouraged for all City of Raleigh contracting opportunities. Please refer to the City's MWBE Policy for any contract specific requirements. *Copy this Form as needed.*

<b>COMPANY NAME</b>			
<b>PROJECT NAME</b>		<b>CITY DEPARTMENT</b>	
<b>PROJECT NUMBER</b>		<b>RFQ SUBMITTAL DATE</b>	

**Section 1: PROFESSIONAL SERVICE PROVIDER—PRIMARY CONTRACTOR**

**CONTRACT IS FOR PROFESSIONAL SERVICES.** Please complete the following:

<b>COMPANY NAME</b>			
<b>PROFESSIONAL SERVICES PROVIDED</b>	<input type="checkbox"/> Architectural <input type="checkbox"/> Engineering <input type="checkbox"/> Public-Private Partnership Construction	<input type="checkbox"/> Design-Build <input type="checkbox"/> Surveying <input type="checkbox"/> Construction Management at Risk	
<input type="checkbox"/> <b>PRIMARY CONTRACTOR IS MWBE</b>	Classification: _____ <input type="checkbox"/> Certified with NCHUB <input type="checkbox"/> Certified with NCDOT-DBE	<b>RESIDENT FIRM</b>	<input type="checkbox"/> <b>YES</b> <input type="checkbox"/> <b>NO</b>

\*MWBE Classifications: American Indian (AI), Asian American (AA), Black/African-American (B), Hispanic (H), Non-Minority Female (NMF), Socially/Economic Disadvantaged (D)

**Section 2: PROFESSIONAL SERVICE PROVIDER—MWBE SUBCONTRACTORS**

Complete the chart below for all MWBE subcontractors that you intend to use for this Contract regardless of dollar amount.

<b>COMPANY NAME</b>			
<b>PROFESSIONAL SERVICES PROVIDED</b>	<input type="checkbox"/> Architectural <input type="checkbox"/> Engineering <input type="checkbox"/> Public-Private Partnership Construction	<input type="checkbox"/> Design-Build <input type="checkbox"/> Surveying <input type="checkbox"/> Construction Management at Risk	
<b>MWBE CLASSIFICATION</b>		<b>RESIDENT FIRM</b>	<input type="checkbox"/> <b>YES</b> <input type="checkbox"/> <b>NO</b>

\*MWBE Classifications: American Indian (AI), Asian American (AA), Black/African-American (B), Hispanic (H), Non-Minority Female (NMF), Socially/Economic Disadvantaged (D)

<b>COMPANY NAME</b>			
<b>PROFESSIONAL SERVICES PROVIDED</b>	<input type="checkbox"/> Architectural <input type="checkbox"/> Engineering <input type="checkbox"/> Public-Private Partnership Construction	<input type="checkbox"/> Design-Build <input type="checkbox"/> Surveying <input type="checkbox"/> Construction Management at Risk	
<b>MWBE CLASSIFICATION</b>		<b>RESIDENT FIRM</b>	<input type="checkbox"/> <b>YES</b> <input type="checkbox"/> <b>NO</b>

\*MWBE Classifications: American Indian (AI), Asian American (AA), Black/African-American (B), Hispanic (H), Non-Minority Female (NMF), Socially/Economic Disadvantaged (D)

<b>COMPANY NAME</b>			
<b>PROFESSIONAL SERVICES PROVIDED</b>	<input type="checkbox"/> Architectural <input type="checkbox"/> Engineering <input type="checkbox"/> Public-Private Partnership Construction	<input type="checkbox"/> Design-Build <input type="checkbox"/> Surveying <input type="checkbox"/> Construction Management at Risk	
<b>MWBE CLASSIFICATION</b>		<b>RESIDENT FIRM</b>	<input type="checkbox"/> <b>YES</b> <input type="checkbox"/> <b>NO</b>

\*MWBE Classifications: American Indian (AI), Asian American (AA), Black/African-American (B), Hispanic (H), Non-Minority Female (NMF), Socially/Economic Disadvantaged (D)

## APPENDIX V

### **CONTRACT STANDARD TERMS AND CONDITIONS**

The contract terms provided herein shall become a part of any contract issued as a result of this solicitation. Any exceptions to the contract terms must be stated in the submittal. Any submission of a proposal without objection to the contract terms indicates understanding and intention to comply with the contract terms. If there is a term or condition that the firm intends to negotiate, it must be stated in the proposal. The successful firm will not be entitled to any changes or modifications unless they were first stated in the proposal. The City of Raleigh reserves the right, at its sole discretion, to reject any or all submittal package(s) containing unreasonable objections to standard City of Raleigh contract provisions.

1. Compensation; Time of Payment

The standard City of Raleigh payment term is NET 30 days from the date of invoice. For prompt payment all invoices should be emailed to ([accountspayable@raleighnc.gov](mailto:accountspayable@raleighnc.gov)) or mail to the City of Raleigh, Accounts Payable, PO Box 590, Raleigh, North Carolina 27602-0590. All invoices must include the Purchase Order Number. Invoices submitted without the correct purchase order number will result in delayed payment.

2. Standard of Care

Engineer shall perform for or furnish to City professional engineering and related services in all phases of the project to which this Contract applies as hereinafter provided. Engineer shall serve as City's prime design professional and engineering representative for the project providing professional engineering consultation and advice with respect thereto. Engineer may employ such Engineer's Consultants as Engineer deems necessary to assist in the performance or furnishing of professional engineering and related services hereunder. Engineer shall not be required to employ any Engineer's Consultant unacceptable to Engineer.

The standard of care for all professional engineering and related services performed or furnished by Engineer under this Contract will be the care and skill ordinarily used by members of Engineer's profession practicing under similar conditions at the same time and in the same locality.

3. Opinions of Probable Construction Cost

Engineer's Opinions of probable Construction Cost provided for herein are to be made on the basis of Engineer's experience and qualifications and represent Engineer's best judgment as an experienced and qualified professional engineer generally familiar with the construction industry. However, since Engineer has no control over the cost of labor, materials, equipment, or services furnished by others, or over the Contractor's methods of determining prices, or over competitive bidding or market conditions, Engineer cannot and does not guarantee that proposals, bids, or actual Construction Cost will not vary from opinions of probable Construction Cost prepared by the Engineer. If the City wishes greater assurance as to probable Construction Cost, City may employ an independent cost estimator.

4. Non-Discrimination

To the extent permitted by North Carolina law, the Parties for themselves, their agents, officials, directors, officers, members, representatives, employees, and contractors agree not to discriminate in any manner or in any form based on actual or perceived age, mental or physical disability, sex, religion, creed, race, color, sexual orientation, gender identity or expression, familial or marital status, economic status, veteran status or national origin in connection with this Contract or its performance.

The Parties agree to conform with the provisions and intent of Raleigh City Code §4-1004 in all matters related to this Contract. This provision is incorporated into the Contract for the benefit of the City of Raleigh and its residents and may be enforced by an action for specific performance, injunctive relief, or any other remedy available at law or equity. This section shall be binding on the successors and assigns of all parties with reference to the subject matter of the Contract.

5. Minority and Women Owned Business Enterprise

The City of Raleigh prohibits discrimination in any manner against any person based on actual or perceived age, race, color, creed, national origin, sex, mental or physical disability, sexual orientation, gender identity or expression, familial or marital status, religion, economic status, or veteran status. The City maintains an affirmative policy of fostering, promoting, and conducting business with women and minority owned business enterprises.

6. Assignment

Neither the City nor the Engineer will assign, sublet, or transfer their interest, duties, or obligations hereunder without the prior written consent of the other. Nothing herein shall be construed as creating any personal liability on the part of any officer or agent of any public body which may be a party hereto, nor shall it create any rights or benefits to parties other than the City and the Engineer, except such other rights as may be specifically called for herein.

7. Applicable Law

All matters relating to this Contract shall be governed by the laws of the State of North Carolina, without regard to its choice of law provisions, and venue for any action relating to this Contract shall be Wake County Civil Superior Court or the United States District Court for the Eastern District of North Carolina, Western Division.

8. Insurance

Contractor agrees to maintain, on a primary basis and at its sole expense, at all times during the life of this Contract the following coverages and limits. The requirements contained herein, as well as City's review or acceptance of insurance maintained by Contractor is not intended to and shall not in any manner limit or qualify the liabilities or obligations assumed by Contractor under this Contract.

Commercial General Liability – Combined single limit of no less than \$1,000,000 each occurrence and \$2,000,000 aggregate. Coverage shall not contain any endorsement(s) excluding nor limiting Product/Completed Operations, Contractual Liability or Cross Liability.

Automobile Liability – Limits of no less than \$1,000,000 Combined Single Limit. Coverage shall include liability for Owned, Non-Owned and Hired automobiles. In the event Contractor does not own automobiles, Contractor agrees to maintain coverage for Hired and Non-Owned Auto Liability, which may be satisfied by way of endorsement to the Commercial General Liability policy or separate Auto Liability policy. Automobile coverage is only necessary if vehicles are used in the provision of services under this Contract and/or are brought on a City site.

Worker's Compensation & Employers Liability – Contractor agrees to maintain Worker's Compensation Insurance in accordance with North Carolina General Statute Chapter 97 with statutory limits and employees liability of no less than \$1,000,000 each accident.

Additional Insured – Contractor agrees to endorse the City as an Additional insured on the Commercial General Liability, Auto Liability and Umbrella Liability if being used to meet the standard of the General Liability and Automobile Liability. The Additional Insured shall read: 'City of Raleigh is named additional insured as their interest may appear'.

Certificate of Insurance – Contractor agrees to provide the City a Certificate of Insurance evidencing that all coverages, limits and endorsements required herein are maintained and in full force and effect, and Certificates of Insurance shall provide a minimum thirty (30) day endeavor to notify, when available, by Contractor's insurer.

If Contractor receives a non-renewal or cancellation notice from an insurance carrier affording coverage required herein, or receives notice that coverage no longer complies with the insurance requirements herein, Contractor agrees to notify the City within five (5) business days with a copy of the non-renewal or cancellation notice, or written specifics as to which coverage is no longer in compliance.

The Certificate Holder address should read:

City of Raleigh  
Post Office Box 590  
Raleigh, NC 27602-0590

Umbrella or Excess Liability – Contractor may satisfy the minimum liability limits required above under an Umbrella or Excess Liability policy. There is no minimum Per Occurrence limit of liability under the Umbrella or Excess Liability, however, the Annual Aggregate limits shall not be less than the highest 'Each Occurrence' limit for required policies. Contractor agrees to endorse City of Raleigh as an 'Additional Insured' on the Umbrella or Excess Liability, unless the Certificate of Insurance states the Umbrella or Excess Liability provides coverage on a 'Follow-Form' basis.

Professional Liability – Limits of no less than \$1,000,000 each claim. This coverage is only necessary for professional services such as engineering, architecture or when otherwise required by the City.

All insurance companies must be authorized to do business in North Carolina and be acceptable to the City of Raleigh's Risk Manager.

10. Indemnity

- A. To the fullest extent allowed by law, the Engineer shall indemnify and hold harmless the City, its officers, officials, employees, agents, or indemnities (collectively called "Indemnified Parties") from and against those Losses, liabilities, damages, and costs proximately caused by, arising out of, or resulting from the sole negligence of the Engineer, the Engineer's agents, or the Engineer's employees.
- B. In matters other than those covered by subsection A. above, and to the fullest extent allowed by law, the Engineer shall indemnify and hold harmless the Indemnified Parties from and against those Losses, liabilities, damages, and costs caused by, arising out of, resulting from, or in connection with the execution of the work provided for in this contract when the Fault of the Engineer or its Derivative Parties is a proximate cause of the Loss, liability, damage, or expense indemnified.
- C. Costs and expenses shall include attorneys' fees, litigation or arbitration expenses, or court costs actually incurred by the Indemnified Parties to defend against third-party claims alleged in any court, tribunal, or alternative dispute resolution procedure required of any of the Indemnified Parties by law or by contract, only if the Fault of the Engineer or its Derivative Parties is a proximate cause of the attorney's fees, litigation or arbitration expenses, or court costs to be indemnified.
- D. Only to the extent provided pursuant to a policy of insurance, the Engineer shall defend the Indemnified Parties against claims alleged in any court, tribunal, or alternative dispute resolution procedure if the Fault of the Engineer or its Derivative Parties is a proximate cause of such claims.
- E. The Engineer's duty to indemnify, defend, and hold harmless described hereinabove shall survive the termination or expiration of this Contract.
- F. Definitions:
  - i. For the purposes of this section, the term "Fault" shall mean any breach of contract; negligent, reckless, or intentional act or omission constituting a tort under applicable statutes or common law; or violation of applicable statutes or regulations.
  - ii. For the purposes of this section, the term "Loss" or "Losses" shall include, but not be limited to, fines, penalties, and/or judgments issued or levied by any local, state, or federal governmental entity.
  - iii. For the purposes of this section, the term "Derivative Parties" shall mean any of the Engineer's subcontractors, agents, employees, or other persons or entities for which the Engineer may be liable or responsible as a result of any statutory, tort, or contractual duty.

11. Intellectual Property

Any information, data, instruments, documents, studies, reports or deliverables given to, exposed to, or prepared or assembled by the Engineer under this Contract shall be kept as confidential proprietary information of the City and not divulged or made available to any individual or organization without the prior written approval of the City. Such information, data, instruments, documents, studies, reports or deliverables will be the sole property of the City and not the Engineer.

The Engineer shall maintain the right of reuse to any drawings or specifications provided or furnished by the Engineer. The City acknowledges that such drawings or specifications are not intended or represented to be suitable for reuse by the City or others on extensions of the project or on any other project.

All intellectual property, including, but not limited to, patentable inventions, patentable plans, copyrightable works, mask works, trademarks, service marks and trade secrets invented, developed, created or discovered in performance of this Contract shall be the property of the City.

Copyright in and to any copyrightable work, including, but not limited to, copy, art, negatives, photographs, designs, text, software, or documentation created as part of the Engineer's performance of this project shall vest in the City. Works of authorship and contributions to works of authorship created by the Engineer's performance of this project are hereby agreed to be 'works made for hire' within the meaning of 17 U.S.C. 201.

12. Force Majeure

Except as otherwise provided in any environmental laws, rules, regulations or ordinances applicable to the parties and the services performed under this Contract, neither party shall be deemed to be in default of its obligations hereunder if and so long as it is prevented from performing such obligations by an act of war, hostile foreign actions, nuclear explosion, earthquake, hurricane, tornado, or other catastrophic natural event or act of God. Either party to the Contract must take reasonable measures and implement reasonable protections when a weather event otherwise defined as a force majeure event is forecast to be eligible to be excused from the performance otherwise required under this Contract by this provision.

13. Communications

If communications to the public and/or City employees are required as part of the Contractor's scope of work under this Contract, then the Contractor shall work with the City in the development of a communications plan ("Communications Plan") that must first be approved by the City in writing before any such communications are delivered to the public and/or City employees.

For purposes of this Section, such written approval by the City shall be provided by electronic mail by the applicable City Communications Department employee who is responsible for reviewing and approving the Communications Plan, such electronic mail to be sent to the electronic mail address listed in Notice section of the contract, as part of the contact information for the Contractor representative identified in the contract Notice section.

Among other things, the Communications Plan must establish whether the City or the Contractor will be responsible for sending any such communications to the public and/or City employees as required either by this Contract or the Communications Plan. The Communications Plan also shall include, but not be limited to, communications objectives, target audience, and deliverables (print, video, website, social, direct, or digital). The Contractor shall comply with the Communications Plan when communicating to the public and/or City employees pursuant to this Contract and the Communications Plan. All such communications shall comply with the City's brand and communications guidelines, as the same may be amended or modified from time to time.

The City's current brand and communications guidelines are incorporated into this Contract by reference and can be found on the City's website here: <https://raleighnc.gov/doing-business/city-brand-guidance-vendors>.

For purposes of this Section, "Communications" is defined as any public or City employee facing information presented in channels such as, but not limited to, a website, mobile applications, social media, printed materials, vehicles, billboards, and videos.

A. Communications Plan Approval:

Any materials, messaging or outreach from the Contractor related to marketing and communications of any service or effort under this Contract must first be reviewed and approved by the City's Communications Department. This is to ensure that the Communications Plan: (i) complies with the City's brand and communication guidelines; (ii) integrates with the City's other communications channels and digital strategy; (iii) meets accessibility guidelines; and (iv) conforms to communications best practices with respect to general user experience.

B. Accessibility Requirements:

For web content that the Contractor is to make accessible to the public and/or City employees as part of an approved Communications Plan that is included in the Contractor's scope of work under this Contract, all web materials including, but not limited to, tools, mobile applications, and websites, generated by, or on behalf of, the Contractor must meet at least the mid-range conformance level, AA compliance of the current Web Content Accessibility Guidelines, as the same may be amended from time to time.

Any such web content generated by, or on behalf of the Contractor, as part of a Communications Plan associated with this Contract shall meet all standards of good cognitive web accessibility, which include the following:

- i. Using proper headings and lists
- ii. Using unique links
- iii. Using alternative text and captions
- iv. Using more white space
- v. Dividing content into more manageable pieces

- vi. Making forms manageable by breaking them into multiple, sequential steps
- vii. Providing a logical reading order
- viii. Being consistent with fonts, colors and locations of page elements
- ix. Offering keyboard access
- x. Offering content in multiple formats
- xi. Understanding minimum contrast

C. Languages:

Digital sites/ tools that are for public use/consumption, including for use by City employees, under a Communications Plan associated with this Contract must have translation module (e.g., G-translate, Weglot) so that the service is available in all languages. At minimum, Spanish translation is required on all such digital sites/tools based on low English proficiency requirements:

- i. In most cases, entities that are recipients of federal financial assistance through U.S. Department of Health and Human Services (HHS) must provide language assistance services in order to comply with their legal obligation to take reasonable steps to ensure meaningful access to their programs by persons with Limited English Proficiency (LEP).

D. Content:

For any communications content that the Contractor is required to generate, or have generated, as part of its scope of work under this Contract, the Contractor shall send such content to City Communications Department staff in raw, high-resolution format for inclusion in communications materials to be made accessible to the public and/or City employees as set forth in the Communications Plan that arises from this Contract (i.e., websites, mobile applications, printed materials collateral, and social media). PDF attachments shall be used only as a last resort and only after written approval by the City, with such written approval to be provided by the City in electronic mail format as described elsewhere in this Section 13.

- i. Contractor shall only provide to the City communications materials for which the City has rights to use, with written documentation of such use rights being provided to the City as requested from time to time by the City in its sole discretion.
- ii. All working files agreed upon for the specific Communications Plan shall be provided to the City Communications Department, i.e., text, graphics, charts and data, infographics, and original native files such as Illustrator, Excel, ArcGIS, etc. Following are the file format specifications:
  - 1. Images: At least 300dpi for printing at actual size; 96dpi and at least 1920x1080px for digital/Web.

2. Video: Any video should be no less than Standard HD (1920x1080) but preferable 4k.
3. Text: Word document using accessibility best practices (heading structure, table of contents, and tables).

14. Advertising

The Engineer shall not use the existence of this Contract, or the name of the City of Raleigh, as part of any advertising without the prior written approval of the City.

15. Acknowledgement of City Brand and Tree Logo Ownership and Restrictions

The City of Raleigh has developed proprietary branding (the "City Brand") centered around the Raleigh tree mark logo (the "Tree Logo"). The City's exclusive rights and ownership in and to the Tree Logo are protected under trademark and copyright, including U.S. Copyright Reg. No. VAU1-322-896, N.C. State Trademark Registration Reg. No. T-23070 and Federal Trademark Registration Reg. No. 5,629,347, as well as under other federal and state laws.

Contractor acknowledges and understands that the City is not conferring any license to Contractor under this Agreement to use or depict the Tree Logo or other aspects of the City Brand.

Contractor shall not make any use or depiction of the Tree Logo or other aspects of the City Brand without the prior express written approval of the City. In this regard, should any materials being produced by Contractor for the City under this Agreement contemplate use or depiction of the Tree Logo, including, but not limited to, printed materials, digital media, signage and/or display materials, Contractor shall proceed under the auspices and direction of the City's Communications Department and shall comply with all guidelines and restrictions governing use or depiction of the Tree Logo.

16. Cancellation

The City may terminate this Contract at any time by providing thirty (30) days written notice to the Engineer. In addition, if Engineer shall fail to fulfill in timely and proper manner the obligations under this Contract for any reason, including the voluntary or involuntary declaration of bankruptcy, the City shall have the right to terminate this Contract by giving written notice to the Engineer and termination will be effective upon receipt. Engineer shall cease performance immediately upon receipt of such notice.

In the event of early termination, Engineer shall be entitled to receive just and equitable compensation for costs incurred prior to receipt of notice of termination and for the satisfactory work completed as of the date of termination and delivered to the City. Notwithstanding the foregoing, in no event will the total amount due to Engineer under this section exceed the total amount due Engineer under this Contract. The Engineer shall not be relieved of liability to the City for damages sustained by the City by virtue of any breach of this Contract, and the City may withhold any payment due to the Engineer for the purpose of setoff until such time as the City can determine the exact amount of damages due the City because of the breach.

Payment of compensation specified in this Contract, its continuation or any renewal thereof, is dependent upon and subject to the allocation or appropriation of funds to the City for the purpose set forth in this Contract.

17. Laws/Safety Standards

The Engineer shall comply with all laws, ordinances, codes, rules, regulations, safety standards and licensing requirements that are applicable to the conduct of its business, including those of Federal, State, and local agencies having jurisdiction and/or authority.

Engineer must comply with *North Carolina Occupational Safety and Health Standards for General Industry 13 NCAC 07F (29CFR 1910)*. In addition, Engineer shall comply with all applicable occupational health and safety and environmental rules and regulations.

Engineer shall effectively manage their safety and health responsibilities including:

a. Accident Prevention

Prevent injuries and illnesses to their employees and others on or near their job site. Contractor managers and supervisors shall ensure personnel safety by strict adherence to established safety rules and procedures.

b. Environmental Protection

Protect the environment on, near, and around their work site by compliance with all applicable environmental regulations.

c. Employee Education and Training

Provide education and training to all contractors employees before they are exposed to potential workplace or other hazards as required by specific OSHA Standards.

18. Applicability of North Carolina Public Records Law

Notwithstanding any other provisions of this Contract, this Contract and all materials submitted to the City by the Engineer are subject to the public records laws of the State of North Carolina and it is the responsibility of the Engineer to properly designate materials that may be protected from disclosure as trade secrets under North Carolina law as such and in the form required by law prior to the submission of such materials to the City. Engineer understands and agrees that the City may take any and all actions necessary to comply with federal, state, and local laws and/or judicial orders and such actions will not constitute a breach of the terms of this Contract. To the extent that any other provisions of this Contract conflict with this paragraph, the provisions of this section shall control.

19. Miscellaneous

The Engineer shall be responsible for the proper custody and care of any property furnished or purchased by the City for use in connection with the performance of this Contract and will reimburse the City for the replacement value of its loss or damage.

The Engineer shall be considered to be an independent contractor and as such shall be wholly responsible for the work to be performed and for the supervision of its employees. Nothing herein is intended or will be construed to establish any agency, partnership, or joint venture. Engineer represents that it has, or will secure at its own expense, all personnel required in performing the services under this Contract. Such employees shall not be employees of or have any individual contractual relationship with the City.

This Contract may be amended only by written agreement of the parties executed by their authorized representatives.

20. Right of Audit and Examination of Records

- a. The City may conduct an audit of any services performed and fees paid subject to this Contract. The City, or its designee, may perform such an audit throughout the contract period and for three (3) years after termination thereof or longer if otherwise required by law.
- b. The Contractor and its agents shall maintain all books, documents, papers, accounting records, contract records and such other evidence as may be appropriate to substantiate costs incurred under this Contract. The City, or its designee, shall have the right to, including but not limited to: review and copy records; interview current and former employees; conduct such other investigation to verify compliance with contract terms; and conduct such other investigation to substantiate costs incurred by this Contract.
- c. "Records" shall be defined as data of every kind and character, including but not limited to books, documents, papers, accounting records, contract documents, information, and materials that, in the City's sole discretion, relate to matters, rights, duties or obligations of this Contract.
- d. Records and employees shall be available during normal business hours upon advanced written notice. Electronic mail shall constitute written notice for purposes of this section.
- e. Contractor shall provide the City or its designee reasonable access to facilities and adequate and appropriate workspace for the conduct of audits.
- f. The rights established under this section shall survive the termination of the Contract, and shall not be deleted, circumvented, limited, confined, or restricted by contract or any other section, clause, addendum, attachment, or the subsequent amendment of this Contract.
- g. The Contractor shall reimburse the City for any overcharges identified by the audit within ninety (90) days of written notice of the City's findings.
- h. Contractor shall, upon request, provide any records associated with this engagement to the North Carolina State Auditor that are necessary to comply with the provisions of G.S. § 147-64.7.

21. E – Verify

Contractor shall comply with E-Verify, the federal E-Verify program operated by the United States Department of Homeland Security and other federal agencies, or any successor or equivalent program used to verify the work authorization of newly hired employees pursuant to federal law and as in accordance with N.C.G.S. §64-25 et seq. In addition, to the best of Contractor's knowledge, any subcontractor employed by Contractor as a part of this contract shall be in compliance with the requirements of E-Verify and N.C.G.S. §64-25 et seq.

22. Iran Divestment Act Certification

Contractor certifies that, as of the date listed below, it is not on the Final Divestment List as created by the State Treasurer pursuant to N.C.G.S. § 147-86.55, *et seq.* In compliance with the requirements of the Iran Divestment Act and N.C.G.S. § 147-86.59, Contractor shall not utilize in the performance of the contract any subcontractor that is identified on the Final Divestment List.

23. Companies Boycotting Israel Divestment Act Certification

Contractor certifies that it has not been designated by the North Carolina State Treasurer as a company engaged in the boycott of Israel pursuant to N.C.G.S. 147-86.81.

## APPENDIX VI

### EXCEPTIONS TO THE RFQ

**CHECK ONE:**

- NO EXCEPTIONS, PROPOSER COMPLIES WITH ALL DOCUMENTS IN RFQ.
- EXCEPTIONS ARE LISTED BELOW:

#	RFQ Page #, Section, Name, Title, Item #	Exceptions (Describe nature of Exception)	Explain Why This is an Issue	Proposed Alternative	Indicate if exception is Negotiable (N), or Non-negotiable (NN)
1					
2					
3					
4					
5					
6					
7					
8					
9					

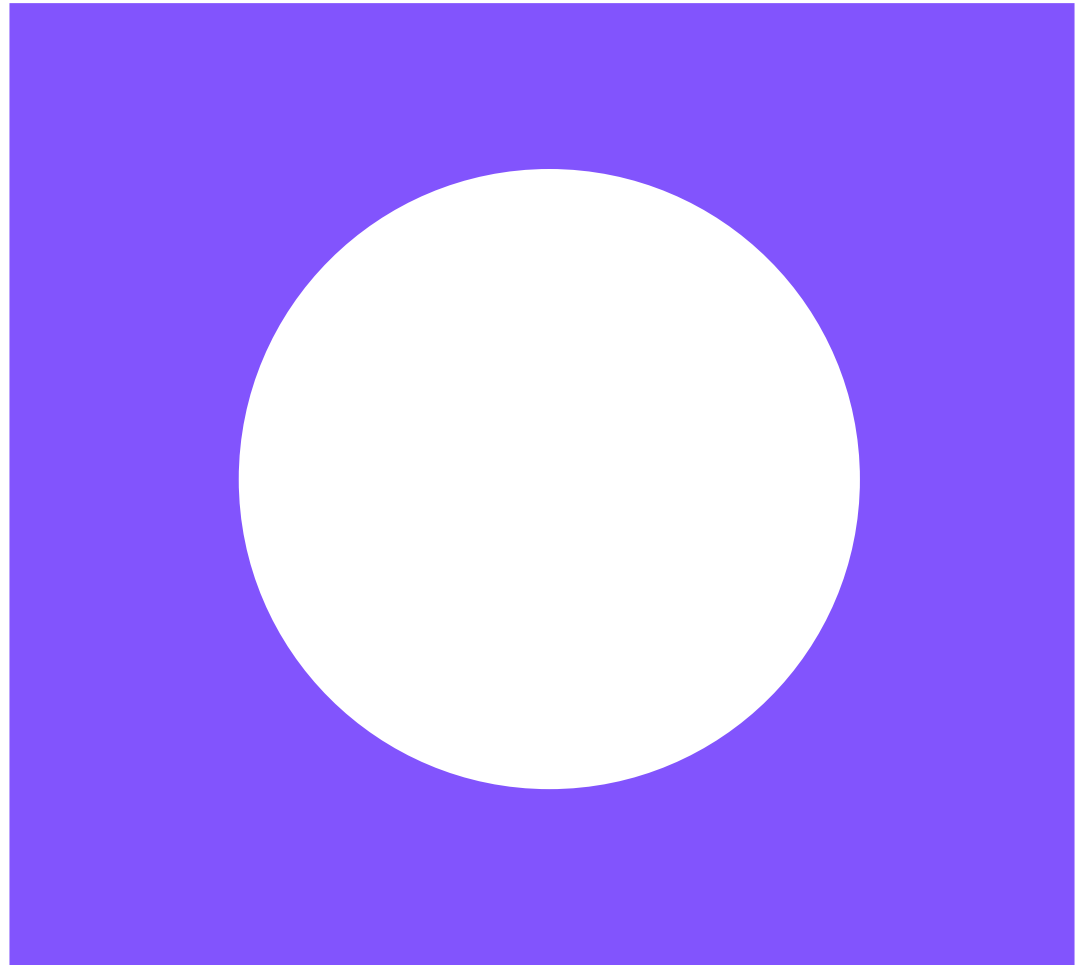
10					
11					
12					

**FAILURE TO IDENTIFY ANY EXCEPTIONS WILL INDICATE ACCEPTANCE OF ALL TERMS AND CONDITIONS, AND REQUIREMENTS OF THE RFQ AND ANY CORRESPONDING ADDENDUM ISSUED. THE CITY, AT ITS SOLE DISCRETION, MAY MODIFY OR REJECT ANY EXCEPTION OR PROPOSED CHANGE.**

Firm:	Authorized Signature:	Title:
Printed Name of Signer:	Date:	



## Appendix VII - City of Raleigh DQMP



# **Data Quality Management Plan for Pavement Data Collection**

City of Raleigh NC

September 2025

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# **Data Quality Management Plan for Pavement Data Collection**

City of Raleigh NC

September 2025

# Issue and revision record

Revision	Date	Description
Version 1.0	8/22/2025	Added vendor requirements to address vehicle wander during calibration runs and long-term storage of data. Added an additional quality check to compare cracking data from a previous data collection. Submission v1.0
Version 1.1	9/2/2025	Updates to tables 3 and 6 to standardize and clarify QC acceptance criteria and follow-up actions. Submission v1.1

**Document reference:**

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This document is issued for the party which commissioned it and for specific purposes connected with the pavement data collection project only. It should not be relied upon by any other party or used for any other purpose.

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# 1 Introduction

This document defines the Data Quality Management Plan (DQMP) for The City of Raleigh, NC for the collection of data according to the ASTM E3303 Standard for automated collection of pavement data. The underlying objective for this document is to create a repeatable process to ensure that data being delivered to support the Pavement Management program and that pavement condition reporting is accurate and repeatable. This ensures that:

- Trends based on quality data are available over time for analysis and reporting.
- Inputs to the pavement management system are reliable and as accurate as possible.

Ideally, a DQMP should address the following:

- A. Data collection equipment calibration and certification;
- B. Data quality control measures to be conducted before data collection begins and periodically during the data collection program;
- C. Data sampling, review and checking processes; and
- D. Error resolution procedures and data acceptance criteria.

These areas are addressed in the following sections:

**Introduction:** This gives the purpose and layout of the document.

**Deliverables, Protocols and Quality Standards:** This section lists the deliverables, including individual data elements, being collected, and the protocols, resolution, accuracy, and repeatability required for each.

**Quality Assurance and Quality Control:** This section gives a description of the QC activities for each deliverable, and the frequency at which the QC activity should be performed. The section is further divided into sub-sections for pre-collection activities, activities carried out during collection, and post-collection activities.

**Acceptance:** This section gives a description of acceptance percentage (%) within limits required for each acceptance test, and the action that will be taken if the acceptance test fails.

**Quality Reporting Plan:** The last section details the reporting that will be performed on the quality management activities, including which role is responsible for generating the reporting.

## 2 Deliverables, Protocols, and Quality Standards

### 2.1 Data Elements

The distresses and individual data elements listed in **Table 1** are required to be collected for use in the City of Raleigh pavement management program. The Quality Management process assumes that data will be collected using the following methods and frequency:

- Automated survey equipment shall be used for all ratings.
- All city-maintained road ratings shall be completed in a single data collection year.
- Lengths of lane exclusions related to bridges, construction, lane deviations, or railroads should be reported for each segment.

**Table 1: Distress Data Elements collected for pavement management**

Data Element <sup>1</sup>	Description
<b>Section-level Inventory Data Elements</b>	
SECTION_ID	City's Unique ID
YEAR	Year of Survey (Defined by the City)
STREET	Street Name
STREET_TYPE	Street Type
BLOCK_NBR	City Block Identifier
CURB_GUTTER	Number of curbs
SIDEWALK	Number of sidewalks
BEG_DESCRIPTION	Beginning point of section
END_DESCRIPTION	End point of section
SECTION_LENGTH	Section Length
SECTION_WIDTH	Section Width
LANES	Number of Lanes
<b>Segment-Level Inventory Data Elements</b>	
DISTANCE_FROM	Linear feet between the start of the data collection segment and a reference point chosen by the data collection team

<sup>1</sup> All data elements to be collected are defined in the City of Raleigh Pavement Data Dictionary (current version)

Data Element <sup>1</sup>	Description
<b>DISTANCE_TO</b>	Linear feet between the end of the data collection segment and a reference point chosen by the data collection team
<b>BEGIN_LATITUDE</b>	Latitude of the beginning of data collection segment
<b>BEGIN_LONGITUDE</b>	Longitude of the beginning of data collection segment
<b>END_LATITUDE</b>	Latitude of the end of data collection segment
<b>END_LONGITUDE</b>	Longitude of the end of data collection segment
<b>SEGMENT_LENGTH</b>	Length of data collection segment (approximately 6 to 6.5 feet) or slab length for concrete pavement
<b>SEGMENT_WIDTH</b>	Width of data collection segment (up to approx. 12 feet)
<b>SEGMENT_AREA</b>	Width of data collection segment (up to approx. 12 feet)
<b>SURVEY_DATE</b>	Date that data was collected for the segment
<b>SURVEY_TIME</b>	Approximate time of image capture
<b>VEHICLE_SURVEY</b>	Data Collection Vendor Survey Vehicle ID
<b>SPEED_MPH</b>	Speed of vehicle during data collection
<b>COLLECTION_DIRECTION</b>	Linear feet between the start of the data collection segment and a reference point chosen by the data collection team
<b>TEMPERATURE</b>	Linear feet between the end of the data collection segment and a reference point chosen by the data collection team
<b>Segment-Level Condition Data Elements</b>	
<b>TOT_CRK_LEN</b>	Total length of cracking for data collection segment
<b>CRCK_WID_AVG</b>	Weighted Average Width of Cracking
<b>CRKD</b>	Crack Density
<b>CRKD_H</b>	Crack Density of cracks having width > 0.25"
<b>CRKD_L</b>	Crack Density of cracks having width <= 0.25"
<b>PSCM</b>	Pavement Surface Cracking Metric = crack density x weighted crack width (in feet)
<b>IRI_LWP</b>	Roughness - IRI (Left wheel path)
<b>IRI_RWP</b>	Roughness - IRI (Right wheel paths)
<b>RUT_LWP</b>	Rutting (Left wheel path)
<b>RUT_RWP</b>	Rutting (Right wheel path)
<b>POTHoles</b>	Area affected by potholes
<b>Segment-Level Condition Data Elements by Zone</b>	
<b>CRKD_H_Z1</b>	Crack density of cracks having widths ≥ 0.25" measured as crack length per unit area of data collection segment

Data Element <sup>1</sup>	Description
<b>CRKD_L_Z1</b>	Crack density of cracks having widths < 0.25” measured as crack length per unit area of data collection segment
<b>CRK_LEN_Z1</b>	Length of Cracking
<b>AREA_Z1</b>	Area of Analysis
<b>CRK_WID_Z1</b>	Weighted Average Width of Cracking
<b>CRKD_Z1</b>	Crack Density (Crack Length / Interval Area)
<b>PSCM_Z1</b>	Pavement Surface Cracking Metric = crack density x weighted crack width (in feet)
<b>CRKD_H_Z2</b>	Crack density of cracks having widths ≥ 0.25” measured as crack length per unit area of data collection segment
<b>CRKD_L_Z2</b>	Crack density of cracks having widths < 0.25” measured as crack length per unit area of data collection segment
<b>CRK_LEN_Z2</b>	Length of Cracking
<b>AREA_Z2</b>	Area of Analysis
<b>CRK_WID_Z2</b>	Weighted Average Width of Cracking
<b>CRKD_Z2</b>	Crack Density (Crack Length / Interval Area)
<b>PSCM_Z2</b>	Pavement Surface Cracking Metric = crack density x weighted crack width (in feet)
<b>CRKD_H_Z3</b>	Crack density of cracks having widths ≥ 0.25” measured as crack length per unit area of data collection segment
<b>CRKD_L_Z3</b>	Crack density of cracks having widths < 0.25” measured as crack length per unit area of data collection segment
<b>CRK_LEN_Z3</b>	Length of Cracking
<b>AREA_Z3</b>	Area of Analysis
<b>CRK_WID_Z3</b>	Weighted Average Width of Cracking
<b>CRKD_Z3</b>	Crack Density (Crack Length / Interval Area)
<b>PSCM_Z3</b>	Pavement Surface Cracking Metric = crack density x weighted crack width (in feet)
<b>CRKD_H_Z4</b>	Crack density of cracks having widths ≥ 0.25” measured as crack length per unit area of data collection segment
<b>CRKD_L_Z4</b>	Crack density of cracks having widths < 0.25” measured as crack length per unit area of data collection segment
<b>CRK_LEN_Z4</b>	Length of Cracking
<b>AREA_Z4</b>	Area of Analysis
<b>CRK_WID_Z4</b>	Weighted Average Width of Cracking
<b>CRKD_Z4</b>	Crack Density (Crack Length / Interval Area)

Data Element <sup>1</sup>	Description
<b>PSCM_Z4</b>	Pavement Surface Cracking Metric = crack density x weighted crack width (in feet)
<b>CRKD_H_Z5</b>	Crack density of cracks having widths ≥ 0.25” measured as crack length per unit area of data collection segment
<b>CRKD_L_Z5</b>	Crack density of cracks having widths < 0.25” measured as crack length per unit area of data collection segment
<b>CRK_LEN_Z5</b>	Length of Cracking
<b>AREA_Z5</b>	Area of Analysis
<b>CRK_WID_Z5</b>	Weighted Average Width of Cracking
<b>COMMENTS</b>	Used for reporting issues and exceptions by the Vendor

## 2.2 Data Collection Scope

The following is required by City of Raleigh regarding scope of services by the data collection vendor.

- The data collection vendor shall conduct field surveys on all pavement segments (approximately 1160 miles) of city-maintained roads and suburban streets to identify the distresses listed in **Table 1**.
- The data collection vendor will provide data in a comma separated values (.csv) import file. The data shall be compatible with the city’s Pavement Management System and be in the format defined in the City of Raleigh Pavement Data Dictionary (latest version).
- All city-maintained roadway ratings shall be completed by August 31 of every other calendar year.

The data collection vendor will be required to provide QA/QC to ensure data is reliable. The QA/QC plan should be submitted to City of Raleigh prior to collection of data. This will be the responsibility of the vendor.

## 2.3 Data Protocol, Resolution, Accuracy and Repeatability

The expected data units, resolution, accuracy and repeatability are identified for each data element in **Table 2: Data Protocols, Resolution, Accuracy and Repeatability for Data Elements** below. These requirements will apply to each individual 5-7 ft longitudinal data collection segment within each calibration section specified in **Table 4: Calibration Sites and Number of Repetitions per Site**.

For calibration purposes, zones 1 and 5 may be excluded from data collection in events where zones are less than 3 square feet.

For roughness, a rolling-average window is implemented that calculates the average of a 5-7 ft longitudinal data collection segment and the 5 segments before and after rather than assessing a single segment. The inclusion of more segments in the roughness accuracy verification eliminates the error due to short measurement lengths.

**Table 2: Data Protocols, Resolution, Accuracy and Repeatability for Data Elements**

Data Elements	Units	Protocol	Resolution	Accuracy *	Repeatability
<b>Section-Level Inventory Data Elements</b>					
<b>SECTION_ID</b>	N.A.	N.A.	N.A.	N.A.	N.A.
<b>YEAR</b>	N.A.	N.A.	N.A.	N.A.	N.A.
<b>STREET</b>	N.A.	N.A.	N.A.	N.A.	N.A.
<b>STREET_TYPE</b>	N.A.	N.A.	N.A.	N.A.	N.A.
<b>BLOCK_NBR</b>	N.A.	N.A.	N.A.	N.A.	N.A.
<b>CURB_GUTTER</b>	N.A.	N.A.	N.A.	N.A.	N.A.
<b>SIDEWALK</b>	N.A.	N.A.	N.A.	N.A.	N.A.
<b>BEG_DESCRIPTION</b>	N.A.	N.A.	N.A.	N.A.	N.A.
<b>END_DESCRIPTION</b>	N.A.	N.A.	N.A.	N.A.	N.A.
<b>SECTION_LENGTH</b>	feet	N.A.	N.A.	N.A.	N.A.
<b>SECTION_WIDTH</b>	feet	N.A.	N.A.	N.A.	N.A.
<b>LANES</b>	N.A.	N.A.	N.A.	N.A.	N.A.
<b>Segment-Level Inventory Data Elements</b>					
<b>DISTANCE_FROM</b>	feet	DMI	0.01 feet	±0.1 feet of reference value	Standard Deviation ≤ 0.1 feet or Coefficient of Variation ≤ 5%

Data Elements	Units	Protocol	Resolution	Accuracy *	Repeatability
<b>DISTANCE_TO</b>	feet	DMI	0.01 feet	±0.1 feet of reference value	Standard Deviation ≤ 0.1 feet or Coefficient of Variation ≤ 5%
<b>BEGIN_LATITUDE</b>	decimal degrees	GPS (WGS 1984 / EPSG 4326)	0.00000001 degrees	±0.00004 decimal degrees of reference value	Standard Deviation ≤ 0.00004 feet or Coefficient of Variation ≤ 5%
<b>BEGIN_LONGITUDE</b>	decimal degrees	GPS (WGS 1984 / EPSG 4326)	0.00000001 degrees	±0.00004 decimal degrees of reference value	Standard Deviation ≤ 0.00004 feet or Coefficient of Variation ≤ 5%
<b>END_LATITUDE</b>	decimal degrees	GPS (WGS 1984 / EPSG 4326)	0.00000001 degrees	±0.00004 decimal degrees of reference value	Standard Deviation ≤ 0.00004 feet or Coefficient of Variation ≤ 5%
<b>END_LONGITUDE</b>	decimal degrees	GPS (WGS 1984 / EPSG 4326)	0.00000001 degrees	±0.00004 decimal degrees of reference value	Standard Deviation ≤ 0.00004 feet or Coefficient of Variation ≤ 5%
<b>SEGMENT_LENGTH</b>	feet	N.A.	0.01 feet	±0.1 feet of reference value	Standard Deviation ≤ 0.05 feet or Coefficient of Variation ≤ 5%
<b>SEGMENT_WIDTH</b>	feet	N.A.	0.1 feet	±0.5 feet of reference value	Standard Deviation ≤ 0.5 feet or Coefficient of Variation ≤ 5%
<b>SEGMENT_AREA</b>	square feet	N.A.	0.1 square feet	±2 feet of reference value	Standard Deviation ≤ 1 foot or Coefficient of Variation ≤ 5%
<b>SURVEY_DATE</b>	date	N.A.	N.A.	N.A.	Exact
<b>SURVEY_TIME</b>	time stamp	N.A.	N.A.	N.A.	N.A.
<b>VEHICLE_SURVEY</b>	N.A.	N.A.	N.A.	N.A.	N.A.
<b>SPEED_MPH</b>	MPH	N.A.	1 mph	±5 mph of reference value	Standard Deviation ≤ 5 mph or Coefficient of Variation ≤ 5%

Data Elements	Units	Protocol	Resolution	Accuracy *	Repeatability
<b>COLLECTION_DIRECTI ON</b>	N.A.	N.A.	N.A.	N.A.	N.A.
<b>TEMPERATURE</b>	Degrees Fahrenheit	N.A.	1 degree F	N.A.	Standard Deviation $\leq$ 2.5 degrees F or Coefficient of Variation $\leq$ 5%
<b>Segment-Level Condition Data Elements</b>					
<b>TOT_CRK_LEN</b>	feet	City of Raleigh Pavement Data Dictionary (latest version).	0.1 feet	$\pm$ 15 feet of reference value	Standard Deviation $\leq$ 4 feet or Coefficient of Variation $\leq$ 25%
<b>CRCK_WID_AVG</b>	inches	City of Raleigh Pavement Data Dictionary (latest version).	0.0001 inch	$\pm$ 0.05 inch of reference value	Standard Deviation $\leq$ 0.1 inch or Coefficient of Variation $\leq$ 5%
<b>CRKD</b>	feet / square feet	Image Collection: AASHTO R 86	0.001 feet / square feet	$\pm$ 0.25 feet / square feet of reference value	Standard Deviation $\leq$ 0.25 feet / square feet or Coefficient of Variation $\leq$ 5%
<b>CRKD_H</b>	feet / square feet	Crack lengths: AASHTO R 85	0.001 feet / square feet	$\pm$ 0.1 feet / square feet of reference value	Standard Deviation $\leq$ 0.25 feet / square feet or Coefficient of Variation $\leq$ 5%
<b>CRKD_L</b>	feet / square feet	Density Calculation: City of Raleigh Pavement Data Dictionary - ASTM E3303 (latest version).	0.001 feet / square feet	$\pm$ 0.5 feet / square feet of reference value	Standard Deviation $\leq$ 0.25 feet / square feet or Coefficient of Variation $\leq$ 5%
<b>PSCM</b>	square feet / square feet	ASTM E3303 (latest version.)	0.01 square feet / square feet	$\pm$ 0.25 square feet / square feet	Standard Deviation $\leq$ 0.1 square feet / square feet or Coefficient of Variation $\leq$ 5%

Data Elements	Units	Protocol	Resolution	Accuracy *	Repeatability
IRI_LWP	inches/mile	Collection of Longitudinal Profile and Quantification of IRI: AASHTO R43-13	1 inch / mile	±25 inch per mile (based on running average of 11 6-foot segments or 5 slab-length segments)	Standard Deviation ≤ 15 inches per mile or Coefficient of Variation < 15% (based on running average of 11 6-foot segments or 5 slab-length segments)
IRI_RWP		Certification of IRI data in accordance with: AASHTO R56-14			
RUT_LWP	inches (measured to the nearest 0.01 inch)	AASHTO R 87	0.01 inch	±0.1 inch of reference value	Standard Deviation ≤ 0.1 inch or Coefficient of Variation ≤ 5%
RUT_RWP		AASHTO R 88			
POTHOLES	square feet	City of Raleigh Pavement Data Dictionary (latest version).	0.1 square feet	±2 square feet of reference value	Standard Deviation ≤ 2 square feet or Coefficient of Variation ≤ 5%
<b>Segment-Level Condition Data Elements by Zone (Zone 1)</b>					
CRKD_H_Z1	feet / square feet	Image Collection: AASHTO R 86	0.001 feet / square feet	±0.1 feet / square feet of reference value	Standard Deviation ≤ 0.25 feet / square feet or Coefficient of Variation ≤ 5%
CRKD_L_Z1	feet / square feet	Zone Definition and Crack lengths: AASHTO R 85 (latest version)  Density Calculation: City of Raleigh Pavement Data Dictionary - ASTM E3303 (latest version)	0.001 feet / square feet	±0.1 feet / square feet of reference value	Standard Deviation ≤ 0.25 feet / square feet or Coefficient of Variation ≤ 5%

Data Elements	Units	Protocol	Resolution	Accuracy *	Repeatability
<b>CRK_LEN_Z1</b>	feet	City of Raleigh Pavement Data Dictionary - ASTM E3303 (latest version)	0.1 feet	±5 feet of reference value	Standard Deviation ≤ 2 feet or Coefficient of Variation ≤ 25%
<b>AREA_Z1</b>	square feet	City of Raleigh Pavement Data Dictionary - ASTM E3303 (latest version)	0.1 square feet	±2 feet of reference value	Standard Deviation ≤ 1 foot or Coefficient of Variation ≤ 5%
<b>CRK_WID_Z1</b>	inches	City of Raleigh Pavement Data Dictionary (latest version)	0.0001 inch	±0.05 inch of reference value	Standard Deviation ≤ 0.1 inch or Coefficient of Variation ≤ 5%
<b>CRKD_Z1</b>	feet / square feet	City of Raleigh Pavement Data Dictionary (latest version)	0.001 feet / square feet	±0.25 feet / square feet of reference value	Standard Deviation ≤ 0.25 feet / square feet or Coefficient of Variation ≤ 5%
<b>PSCM_Z1</b>	square feet / square feet	ASTM E3303 (latest version)	0.01 square feet / square feet	±0.25 square feet / square feet of reference value	Standard Deviation ≤ 0.5 square feet / square feet or Coefficient of Variation ≤ 5%
<b>Segment-Level Condition Data Elements by Zone (Zone 2)</b>					
<b>CRKD_H_Z2</b>	feet / square feet	Image Collection: AASHTO R 86	0.001 feet / square feet	±0.1 feet / square feet of reference value	Standard Deviation ≤ 0.25 feet / square feet or Coefficient of Variation ≤ 5%
<b>CRKD_L_Z2</b>	feet / square feet	Zone Definition and Crack lengths: AASHTO R 85 (latest version)  Density Calculation: City of Raleigh Pavement Data Dictionary - ASTM E3303 (latest version)	0.001 feet / square feet	±0.1 feet / square feet of reference value	Standard Deviation ≤ 0.25 feet / square feet or Coefficient of Variation ≤ 5%

Data Elements	Units	Protocol	Resolution	Accuracy *	Repeatability
<b>CRK_LEN_Z2</b>	feet	City of Raleigh Pavement Data Dictionary - ASTM E3303 (latest version)	0.1 feet	±5 feet of reference value	Standard Deviation ≤ 2 feet or Coefficient of Variation ≤ 25%
<b>AREA_Z2</b>	square feet	City of Raleigh Pavement Data Dictionary - ASTM E3303 (latest version)	0.1 square feet	±2 feet of reference value	Standard Deviation ≤ 1 foot or Coefficient of Variation ≤ 5%
<b>CRK_WID_Z2</b>	inches	City of Raleigh Pavement Data Dictionary (latest version)	0.0001 inch	±0.05 inch of reference value	Standard Deviation ≤ 0.1 inch or Coefficient of Variation ≤ 5%
<b>CRKD_Z2</b>	feet / square feet	City of Raleigh Pavement Data Dictionary (latest version)	0.001 feet / square feet	±0.25 feet / square feet of reference value	Standard Deviation ≤ 0.25 feet / square feet or Coefficient of Variation ≤ 5%
<b>PSCM_Z2</b>	square feet / square feet	ASTM E3303 (latest version)	0.01 square feet / square feet	±0.25 square feet / square feet of reference value	Standard Deviation ≤ 0.5 square feet / square feet or Coefficient of Variation ≤ 5%
<b>Segment-Level Condition Data Elements by Zone (Zone 3)</b>					
<b>CRKD_H_Z3</b>	feet / square feet	Image Collection: AASHTO R 86	0.001 feet / square feet	±0.1 feet / square feet of reference value	Standard Deviation ≤ 0.25 feet / square feet or Coefficient of Variation ≤ 5%
<b>CRKD_L_Z3</b>	feet / square feet	Zone Definition and Crack lengths: AASHTO R 85 (latest version)  Density Calculation: City of Raleigh Pavement Data Dictionary - ASTM E3303 (latest version)	0.001 feet / square feet	±0.1 feet / square feet of reference value	Standard Deviation ≤ 0.25 feet / square feet or Coefficient of Variation ≤ 5%

Data Elements	Units	Protocol	Resolution	Accuracy *	Repeatability
<b>CRK_LEN_Z3</b>	feet	City of Raleigh Pavement Data Dictionary - ASTM E3303 (latest version)	0.1 feet	±5 feet of reference value	Standard Deviation ≤ 2 feet or Coefficient of Variation ≤ 25%
<b>AREA_Z3</b>	square feet	City of Raleigh Pavement Data Dictionary - ASTM E3303 (latest version)	0.1 square feet	±2 feet of reference value	Standard Deviation ≤ 1 foot or Coefficient of Variation ≤ 5%
<b>CRK_WID_Z3</b>	inches	City of Raleigh Pavement Data Dictionary (latest version)	0.0001 inch	±0.05 inch of reference value	Standard Deviation ≤ 0.1 inch or Coefficient of Variation ≤ 5%
<b>CRKD_Z3</b>	feet / square feet	City of Raleigh Pavement Data Dictionary (latest version)	0.001 feet / square feet	±0.25 feet / square feet of reference value	Standard Deviation ≤ 0.25 feet / square feet or Coefficient of Variation ≤ 5%
<b>PSCM_Z3</b>	square feet / square feet	ASTM E3303 (latest version)	0.01 square feet / square feet	±0.25 square feet / square feet of reference value	Standard Deviation ≤ 0.5 square feet / square feet or Coefficient of Variation ≤ 5%
<b>Segment-Level Condition Data Elements by Zone (Zone 4)</b>					
<b>CRKD_H_Z4</b>	feet / square feet	Image Collection: AASHTO R 86	0.001 feet / square feet	±0.1 feet / square feet of reference value	Standard Deviation ≤ 0.25 feet / square feet or Coefficient of Variation ≤ 5%
<b>CRKD_L_Z4</b>	feet / square feet	Zone Definition and Crack lengths: AASHTO R 85 (latest version)  Density Calculation: City of Raleigh Pavement Data Dictionary - ASTM E3303 (latest version)	0.001 feet / square feet	±0.1 feet / square feet of reference value	Standard Deviation ≤ 0.25 feet / square feet or Coefficient of Variation ≤ 5%

Data Elements	Units	Protocol	Resolution	Accuracy *	Repeatability
<b>CRK_LEN_Z4</b>	feet	City of Raleigh Pavement Data Dictionary - ASTM E3303 (latest version)	0.1 feet	±5 feet of reference value	Standard Deviation ≤ 2 feet or Coefficient of Variation ≤ 25%
<b>AREA_Z4</b>	square feet	City of Raleigh Pavement Data Dictionary - ASTM E3303 (latest version)	0.1 square feet	±2 feet of reference value	Standard Deviation ≤ 1 foot or Coefficient of Variation ≤ 5%
<b>CRK_WID_Z4</b>	inches	City of Raleigh Pavement Data Dictionary (latest version)	0.0001 inch	±0.05 inch of reference value	Standard Deviation ≤ 0.1 inch or Coefficient of Variation ≤ 5%
<b>CRKD_Z4</b>	feet / square feet	City of Raleigh Pavement Data Dictionary (latest version)	0.001 feet / square feet	±0.25 feet / square feet of reference value	Standard Deviation ≤ 0.25 feet / square feet or Coefficient of Variation ≤ 5%
<b>PSCM_Z4</b>	square feet / square feet	ASTM E3303 (latest version)	0.01 square feet / square feet	±0.25 square feet / square feet of reference value	Standard Deviation ≤ 0.5 square feet / square feet or Coefficient of Variation ≤ 5%
<b>Segment-Level Condition Data Elements by Zone (Zone 5)</b>					
<b>CRKD_H_Z5</b>	feet / square feet	Image Collection: AASHTO R 86	0.001 feet / square feet	±0.1 feet / square feet of reference value	Standard Deviation ≤ 0.25 feet / square feet or Coefficient of Variation ≤ 5%
<b>CRKD_L_Z5</b>	feet / square feet	Zone Definition and Crack lengths: AASHTO R 85 (latest version)  Density Calculation: City of Raleigh Pavement Data Dictionary - ASTM E3303 (latest version)	0.001 feet / square feet	±0.1 feet / square feet of reference value	Standard Deviation ≤ 0.25 feet / square feet or Coefficient of Variation ≤ 5%

Data Elements	Units	Protocol	Resolution	Accuracy *	Repeatability
<b>CRK_LEN_Z5</b>	feet	City of Raleigh Pavement Data Dictionary - ASTM E3303 (latest version)	0.1 feet	±5 feet of reference value	Standard Deviation ≤ 2 feet or Coefficient of Variation ≤ 25%
<b>AREA_Z5</b>	square feet	City of Raleigh Pavement Data Dictionary - ASTM E3303 (latest version)	0.1 square feet	±2 feet of reference value	Standard Deviation ≤ 1 foot or Coefficient of Variation ≤ 5%
<b>CRK_WID_Z5</b>	inches	City of Raleigh Pavement Data Dictionary (latest version)	0.0001 inch	±0.05 inch of reference value	Standard Deviation ≤ 0.1 inch or Coefficient of Variation ≤ 5%
<b>CRKD_Z5</b>	feet / square feet	City of Raleigh Pavement Data Dictionary (latest version)	0.001 feet / square feet	±0.25 feet / square feet of reference value	Standard Deviation ≤ 0.25 feet / square feet or Coefficient of Variation ≤ 5%
<b>PSCM_Z5</b>	square feet / square feet	ASTM E3303 (latest version)	0.01 square feet / square feet	±0.25 square feet / square feet of reference value	Standard Deviation ≤ 0.5 square feet / square feet or Coefficient of Variation ≤ 5%
<b>COMMENT ***</b>	N.A.	N.A.	N.A.	N.A.	N.A.

\* These values are with respect to the reference value determined for the data collection cycle. Unless otherwise stated, this value is the mean of the initial calibration runs.

\*\* Determination of the reference value for Total Crack Length can be found in section of this document.

\*\*\* The COMMENT field is for use by the vendor for exception reporting or to capture important information on a segment.

### 3 Quality Assurance and Quality Control

The data collection vendor is required to submit a quality assurance (QA), quality control (QC) plan to the City of Raleigh as part of their proposal. City of Raleigh will review and approve the plan to check it has at a minimum the required elements as defined in this document, as well as approve the results of the QC activities defined below in **Table 3**.

Quality assurance focuses on procedures and processes to ensure quality. Quality control focuses on the activities that will be performed to check the quality of the data being collected.

Required QC activities are summarized below in **Table 3**. The individual activities are then described in more detail in the subsequent sections. The activities and sections are categorized into:

- Activities required prior to the main data collection effort
- Activities required during collection
- Activities required at the end of the data collection prior to final acceptance

**Table 3: QC Activities**

Activity <sup>2</sup>	Quality Expectation	QC Check and Responsibility	Frequency
<b>Pre-Approval of Equipment and Methods</b>	Vendor warrants that equipment and methods meet specifications identified in <b>Table 2</b> of the DQMP and that data elements are collected in accordance with protocols in <b>Table 2</b> of the DQMP.	Review and approval by City of Raleigh <sup>3</sup> of Vendor Startup Report	Pre-collection (as part of Vendor Startup Report)
<b>Pre-Approval of Quality Management Plan</b>	Vendor submits a Quality Management Plan that addresses items including list in section below discussing the <b>Vendor Quality Management Plan</b> .	Review and approval by City of Raleigh of Vendor Quality Management Plan	Pre-collection (as part of Vendor Startup Report)
<b>Initial Calibration</b>	Data meets acceptance requirements from <b>Table 6</b> of the DQMP for the designated number of runs for each calibration test site.	Review and approval by City of Raleigh of Startup Report	Pre-collection (as part of Vendor Startup Report)
<b>Calibration Verification</b>	Data meets acceptance requirements from <b>Table 6</b> of the DQMP for the designated number of runs for each calibration test site.	Approval by City of Raleigh of Monthly Data Submission Deliverable	Monthly (typically as part of monthly vendor data submission)

<sup>2</sup> QC activities are summarized here and described in detail in the remainder of this section. The acceptance criteria and corrective actions are described in the following section relating to Acceptance below

<sup>3</sup> Review and approval by City of Raleigh denotes review and approval by pavement management staff. This applies for all QC Activities relating to the Vendor Startup Report

Activity <sup>2</sup>	Quality Expectation	QC Check and Responsibility	Frequency
<b>Ongoing Exception Monitoring</b>	Segments that cannot be collected should be flagged and reported by the vendor in an Exception Report according to the Vendor's Quality Management Plan.	Certification by City of Raleigh that Exceptions are within Acceptance limits and defined in the vendor QMP.	Monthly (as a separate Vendor Exception Report)
<b>Independent Bounds and Format Checking</b>	Inspect 100% of uploaded data samples to ensure within normal bounds and in the required format.  Minimum data checks:  IRI  $30 \leq \text{IRI} \leq 600$ inches/mile  Rutting  $0 \leq \text{Rutting} \leq 1$ inch  Cracking  $0 \leq \text{Crack Density} \leq 9$ feet / square feet	Independent data check by City of Raleigh to confirm normal bounds in Vendor collected data.	Prior to final acceptance  (as part of Independent Quality Report)
<b>Independent Image Sample Checking</b>	Inspect a random sample of <b>75</b> pavement images with traced cracking overlay against associated uploaded data to ensure distress data derived from LCMS is accurate.	Independent data check by City of Raleigh to confirm Vendor's distress ratings.	Prior to final acceptance  (as part of Independent Quality Report)
<b>Independent Distance and Location Verification</b>	Inspect a random sample of <b>75</b> segments for location data by plotting on a GIS map using provided GPS data and comparing accuracy to underlying base map locations based on GIS_ID.	Independent location data check by City of Raleigh to confirm Vendor's location data.	Prior to final acceptance  (as part of Independent Quality Report)
<b>Previous Collection Variance Checking</b>	Compare management section data against previous data collection cycle for differences in average crack density per zone collected by every van. Ensure that data meets acceptance requirements of the DQMP.	Independent data check by City of Raleigh or Representative to confirm Vendor's distress ratings.	Prior to final acceptance  (as part of Independent Quality Report)
<b>Final Data Review</b>	<b>Scope</b>  Data coverage (excluding identified occurrences e.g. construction, railroad crossings, bridges, etc.) > <b>99.9%</b> .  <b>Within bounds</b>	Approval by City of Raleigh of Final Data Submission Deliverable	Prior to final acceptance (as part of final Independent Quality Report)

Activity <sup>2</sup>	Quality Expectation	QC Check and Responsibility	Frequency
	Data within bounds specified in the bounds checks > <b>98%</b>		

### 3.1 Pre-Collection Activities

A vital part of quality management is to ensure that any vendor awarded a contract has equipment matching the required standards and protocols, as well as sound standard operating procedures and training for their equipment operators.

#### 3.1.1 Pre-approval of Vendor Quality Management Plan

It is important that Vendor maintains a Quality Management Plan, but it is understood that these may cover somewhat different aspects of quality management and be formatted according to the vendor’s preferences. Nonetheless, vendors’ Quality Management Plans should address, at a minimum, QC areas including but not limited to:

- Image capture methods and QC,
- Automated Crack detection image processing and QC,
- Pavement profile data processing and QC (including block test and bounce test frequency),
- Distance and location measurement QC and exception handling (bridges, construction zones, etc.),
- Handling of multiple vehicles,
- Handling of equipment adjustment and repairs,
- Handling of adverse weather conditions,
- Handling of any issues with imagery that affect data quality (bad pixels, camera misalignment, etc.)
- Automated and manual flagging, handling, monitoring and reporting of invalid data,
- Personnel training and certification,
- Vendor quality management roles and responsibilities,
- Explicitly, the vendor should explain how they intend to minimize the effects of the vehicle wander (where vehicle does not follow the same path every time) and DMI drift by ensuring images are segmented the same across runs both longitudinally and transversely during initial calibration and calibration verification runs,
- Detail plan for long-term storage of all raw data and images.

#### 3.1.2 Vendor Startup Report

The data collection vendor must undertake a pavement data collection start-up process for every collection effort. The startup process must be finished (including City of Raleigh review) before production data may be collected.

The results of these pre-collection activities shall be reported by the vendor in a Vendor Startup Report.

The start-up process must include the following:

1. The data collection vendor shall provide all pavement data collection start-up work, reported at one time in a Vendor Startup Report.
2. An initial pavement data collection/processing validation, verification and calibration exercise shall be carried out on calibration roadway sections selected by City of Raleigh based on the number of sections and repetitions defined in **4: Calibration Sites and Number of Repetitions per Site**.
3. During this exercise, the contractor will submit data to City of Raleigh or their representative who will conduct accuracy and precision tests for all data elements based on the accuracies and precisions defined in **Table 2: Data Protocols, Resolution, Accuracy and Repeatability for Data Elements**.
4. In addition, calibration procedures, camera angles and coverage, data calculation methods and standard operating procedures will be verified according to the Vendor Data Quality Management Plan.
5. The City of Raleigh Project Manager must approve the Startup Report and its findings in writing before future work is undertaken.

### 3.1.3 Pre-Approval of Equipment and Methods

For equipment used to collect condition measurements, the data collection vendor shall certify in the startup report that the protocols for initial certification and ongoing data collection specified in **Table 2** are met.

## 3.2 Initial Calibration of Automated Equipment

### 3.2.1 Calibration Sites and Number of Repetitions per Site

Prior to the start of every data collection effort, a set of initial calibration sites shall be chosen to adequately represent the current pavement types. The number of initial calibration sites shall be at least as many as the number given in **Table 4**.

**Table 4: Calibration Sites and Number of Repetitions per Site**

Pavement Type	Approximate CL Length	Number of Sites	Number of Repetitions per Site
Asphalt	0.1 miles	2	5
Composite	0.1 miles	N/A	N/A
Surface Treated	0.1 miles	N/A	N/A
PCC	0.1 miles	N/A	N/A

Sites should be chosen according to the criteria given in **Table 5: Criteria for Selecting Calibration Sites**.

**Table 5: Criteria for Selecting Calibration Sites**

Criteria for selecting Calibration Sites
Straight and flat with minimal traffic.
Must have machine-readable center and edge lane markings on both sides of the lane that are recognizable by the crack monitoring technology for automatic registration and alignment of transverse zones. An optical trigger (e.g. paint on the pavement that will remain throughout the data collection cycle) should be used at both the start and end of the section.
Should have a lead in and exit lengths before and after the section of at least 300 ft.
Try to minimize drive time between sections.
Sites can be contiguous but avoid more than 3 at a route location.
Avoid bridges and approaches.
Avoid sections with lane deviations if possible.
Avoid recent construction.
Sections with medium (not extreme) distresses, with representative cross-section within the range.
Sections should include a range of distress extent and severity.

**3.2.2 Calibration Reference Value Data Collection and Review**

For crack length measurements, the calibration shall be checked as follows:

- Prior to evaluating each site to check crack length detection calibration, the data collection vehicles should have already completed the required repeat runs. The images from a randomly selected run should then be made available, with the overlaid LCMS crack detection and distress identification and quantification, to the City of Raleigh QC/QA designated person checking calibration.
- Using the LCMS images, the actual cracking on the ground will be checked against the cracks measured by the LCMS.
- The beginning of the calibration section covered by the LCMS imagery should be found on the road (e.g. using GPS coordinates).
- For each crack location, where there is a discrepancy between the observed cracking on the ground and the cracking marked up in the images, a discrepancy should be recorded with the length of the discrepancy noted. Note that discrepancies where a crack is missed by the LCMS, and also where cracks are wrongly identified by the LCMS, should both be recorded. Crack lengths less than a foot long will not be evaluated. Only discrepancies totaling more than 1 linear foot of cracking should be recorded. Only cracks with width greater than or equal to 1 mm as defined in AASHTO R 85-18 should be considered.

- The total absolute length of the discrepancies defines the reference discrepancy value for use in density calculation. This reference discrepancy value should be checked against the accuracy requirement from **Table 2**.
- Repeatability of crack length or density measurement should be checked against the requirements from **Table 2**. All calibration sites should be checked for repeatability which is not dependent on manual measurement and is purely a function of the automated runs.

For the purposes of statistical calculations for repeatability and accuracy, all crack length and crack width data elements will be reported as null for segments with no observed cracks.

In the case of IRI, Rutting, Faulting and other non-cracking measurements, because it shall be certified that the data collection vehicles have been calibrated for these measurements, the reference value will be assumed to be the average of the repeat runs. This reference value will be used for all subsequent calibration verification checks during the remainder of the data collection effort.

The reference values obtained should be compared to the previous calibration reference values to check they are within the acceptable limits defined in **Table 2: Data Protocols, Resolution, Accuracy and Repeatability for Data Elements**.

As an alternate approach to the field visit, software provided by a data collection vendor or any GIS software in conjunction with vendor-provided images can be used to detect discrepancies and determine the reference value.

Multiple data collection runs should be made on each calibration section as defined in Table 4: Calibration Sites and Number of Repetitions per Site. The average and standard deviation of the data collection runs compared to the reference values, as well as whether these meet the accuracy and repeatability requirements defined in **Table 2 - Data Protocols, Resolution, Accuracy and Repeatability**, should be reported in the Vendor Startup Report.

The measurement of cracking distress is a two-stage process: first the LCMS initially measures crack length and width, and then this 'raw' information may be translated into distress metrics. Because the initial step of tracing cracks is independent of the second step, the processing of the crack data into distress metrics, if the initial cracks are detected properly, it is not necessary to redo this step if there is a problem only with the second step. As a result, once the crack length and density calibration has been verified, it is possible to allow the Vendor to begin data collection, under the assumption that the processing step can be repeated multiple times independently to ensure distress metric processing calibration.

### 3.3 Production Activities

#### 3.3.1 Calibration Verification at Calibration Sites

Calibration verification will take place on all calibration sites defined for initial calibration.

The data collection vendor will undertake a calibration verification process according to the frequency defined in **Table 3: QC Activities**.

It will be required to make 5 repeat runs on each calibration site for calibration verification. The reference values obtained in the initial calibration for each distress on each calibration site will be used for evaluation of accuracy.

The vendor will deliver the results of this calibration verification as part of the monthly data submission. The vendor may continue to collect data prior to approval of the monthly data submission but will do so at risk. If the monthly data submission is not approved, the vendor will be required to follow the acceptance process defined in **Table 6: QC Acceptance Requirements**.

### **3.3.2 Initial Data Collection Segment dataset:**

The vendor will deliver an initial dataset of the first approximately 100 data collection segments (approximately 6 ft segments) in the format specified in the Data Dictionary. This data will be used to verify that the data is in the correct format for input to the pavement management system.

### **3.3.3 Vendor Exception Monitoring**

The vendor will deliver a Vendor Exception Report according to the frequency defined in **Error! Reference source not found.** and based on the format defined in the section **Quality Reporting Plan**. This report will list all exceptions identified in the data for the previous reporting time interval. The segments listed in the report will contain comments justifying the reason for exceptions.

### **3.3.4 Independent Bounds and Format Checking**

City of Raleigh or its designated representative, will use a database or spreadsheet checking method to check data being delivered based on the bounds and frequency defined in **Table 3: QC Activities** for independent bound checking.

### **3.3.5 Independent Image Sample Checking**

City of Raleigh or its designated representative, will use a manual method to spot check that data being delivered based on LCMS measurements remains accurate and that there are no major discrepancies.

### **3.3.6 Independent Distance and Location Verification**

City of Raleigh or its designated representative, will use a manual method to spot check that the location information of data being delivered is accurate by spot checking GPS and location data by plotting on a GIS map with appropriately accurate layers.

## **3.4 Post-Production Activities**

### **3.4.1 Previous Collection Variance Checking**

City of Raleigh, or its designated representative, will check the difference in the average crack density when compared to the most recent previous round of collection when this exists. This is intended to flag any problems that may not be apparent through other data checks.

### 3.4.2 Final Data Coverage and Bounds review

Prior to final acceptance of the data, checks for completeness of overall scope and that all data is within bounds will be conducted by either City of Raleigh or their designated representative in accordance with the specifications defined in **Table 3: QC Activities**.

# 4 Acceptance

The focus of acceptance is to validate that deliverables meet the established quality standards. Following in **Table 6** is a description of acceptance testing, the frequency to be performed, and corrective actions for items that fail to meet criteria.

**Table 6: QC Acceptance Requirements**

QC Activity	Acceptance (Percent within Limits)	Acceptance Testing and Frequency	Action if Criteria not Met
<b>Pre-approval of Vendor Quality Management Plan</b>	N/A	Vendor Quality Management Plan is checked to ensure that, at a minimum, it addresses items required. Certification of Vendor Quality Management Plan	Deliverable returned with comments for correction.
<b>Pre-Approval of Equipment and Methods</b>	N/A	Vendor warrants that equipment and methods meet specifications identified in <b>Table 2</b> of the DQMP and that data elements are collected in accordance with protocols in <b>Table 2</b> of the DQMP. Part of Certification of Vendor Startup Report	Data collection cannot commence until Acceptance criteria are met.
<b>Initial Calibration of Automated Equipment</b>	≥ <b>85%</b> of 6 ft data collection segments within the calibration sections within all limits. No more than <b>10%</b> of segments failing 3 or more acceptance criteria	Data meets acceptance requirements for the designated number of runs for each calibration test site. Part of Certification of Startup Report	Problems are discussed with vendor and dealt with on a case-by-case basis. If problems cannot be resolved, City of Raleigh reserves the right to withhold payment.  <b>Exception:</b> If it is determined that the crack detection in the images is not a problem and that the only problems are due to accuracy limits based on processing of the cracking data into distress types, the vendor shall be allowed to proceed but must work with

QC Activity	Acceptance (Percent within Limits)	Acceptance Testing and Frequency	Action if Criteria not Met
			City of Raleigh or their representative to ensure crack processing parameters are determined that result in distress measurements that meet acceptance limits. No data will be accepted for which the full pre- and post-calibration verification has not been approved.
<b>Calibration Verification at Calibration Sites</b>	≥ <b>85%</b> of 6 ft data collection segments within all limits. No more than <b>10%</b> of segments failing 3 or more acceptance criteria.	Data meets acceptance requirements from Table 2 of the DQMP for the designated number of runs for each calibration test site. Part of Approval of Monthly Data Submission Deliverable.	Problems are discussed with vendor and dealt with on a case-by-case basis. If problems cannot be resolved, City of Raleigh reserves the right to withhold payment.
<b>Vendor Exception Monitoring</b>	Data coverage (excluding identified occurrences e.g. construction, railroads, etc.) > <b>99.9%</b> .	Exceptions and invalid data should be flagged and reported in a Vendor Exception Report according to the Vendor's Quality Management Plan. Part of Approval of Monthly Data Submission Deliverable and/or Final Data Submission Deliverable.	Problems are discussed with vendor and dealt with on a case-by-case basis. If problems cannot be resolved, City of Raleigh reserves the right to withhold payment.
<b>Independent Bounds and Format Checking</b>	≥ <b>90%</b> of segments within all bounds. No more than <b>10%</b> of segments failing multiple bounds.	Inspect 100% of uploaded data samples to ensure within normal bounds and in the required format. Part of Approval of Monthly Data Submission Deliverable and/or Final Data Submission Deliverable.	Problems are discussed with vendor and dealt with on a case-by-case basis. If problems cannot be resolved, City of Raleigh reserves the right to withhold payment.

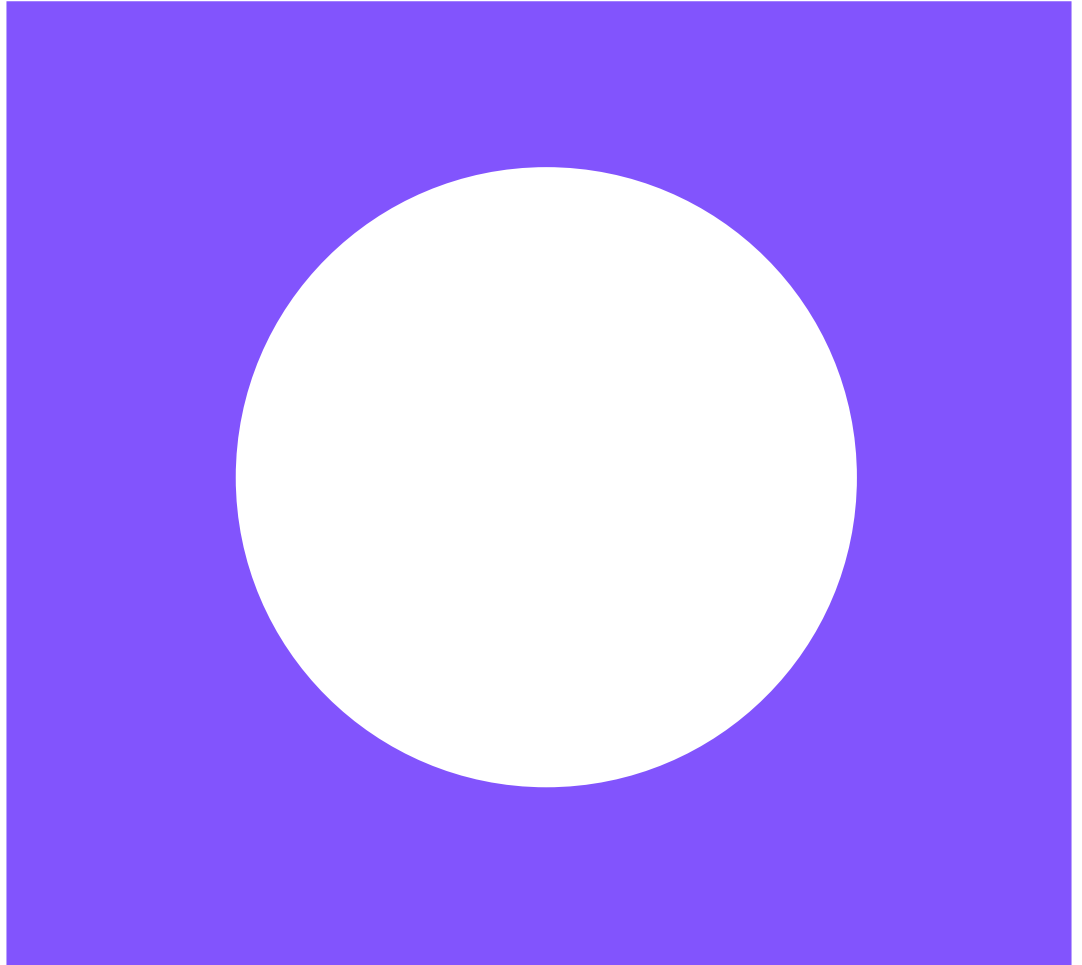
QC Activity	Acceptance (Percent within Limits)	Acceptance Testing and Frequency	Action if Criteria not Met
<b>Independent Image Sample Checking</b>	<b>100%</b> of samples free of major problems.	Inspect a random sample of 75 images against associated uploaded data to ensure distress data derived from LCMS or video data is accurate. Part of Approval of Monthly Data Submission Deliverable and/or Final Data Submission Deliverable.	Problems are discussed with vendor and dealt with on a case-by-case basis. If problems cannot be resolved, City of Raleigh reserves the right to withhold payment.
<b>Independent Distance and Location Verification</b>	<b>100%</b> of samples free of major problems.	Part of Approval of Monthly Data Submission Deliverable and/or Final Data Submission Deliverable.	Problems are discussed with vendor and dealt with on a case-by-case basis. If problems cannot be resolved, City of Raleigh reserves the right to withhold payment.
<b>Previous Collection Variance Checking</b>	Difference in mean of average crack density per zone for the sample sections is less than <b>0.5 ft/sf</b> for <b>100%</b> of all sections across all zones when compared to previous round of collection. This process can be done in Python.	Review all sections gathered during a one-week period for a Monthly Data Submission Deliverable and/or Final Data Submission Deliverable. Discrepancies and invalid data should be flagged.	Problems are discussed with vendor and dealt with on a case-by-case basis. If problems cannot be resolved, City of Raleigh reserves the right to withhold payment.
<b>Final Data Coverage and Bounds Review</b>	Scope-Data coverage (excluding identified occurrences e.g. construction, railroads, etc.) > <b>99.9%</b> . Data within bounds specified in the bounds checks > <b>98%</b>	Approval of Final Data Submission Deliverable. Part of Final Acceptance.	Vendor to continue work to meet acceptance criteria. Payment withheld until acceptance criteria are met.

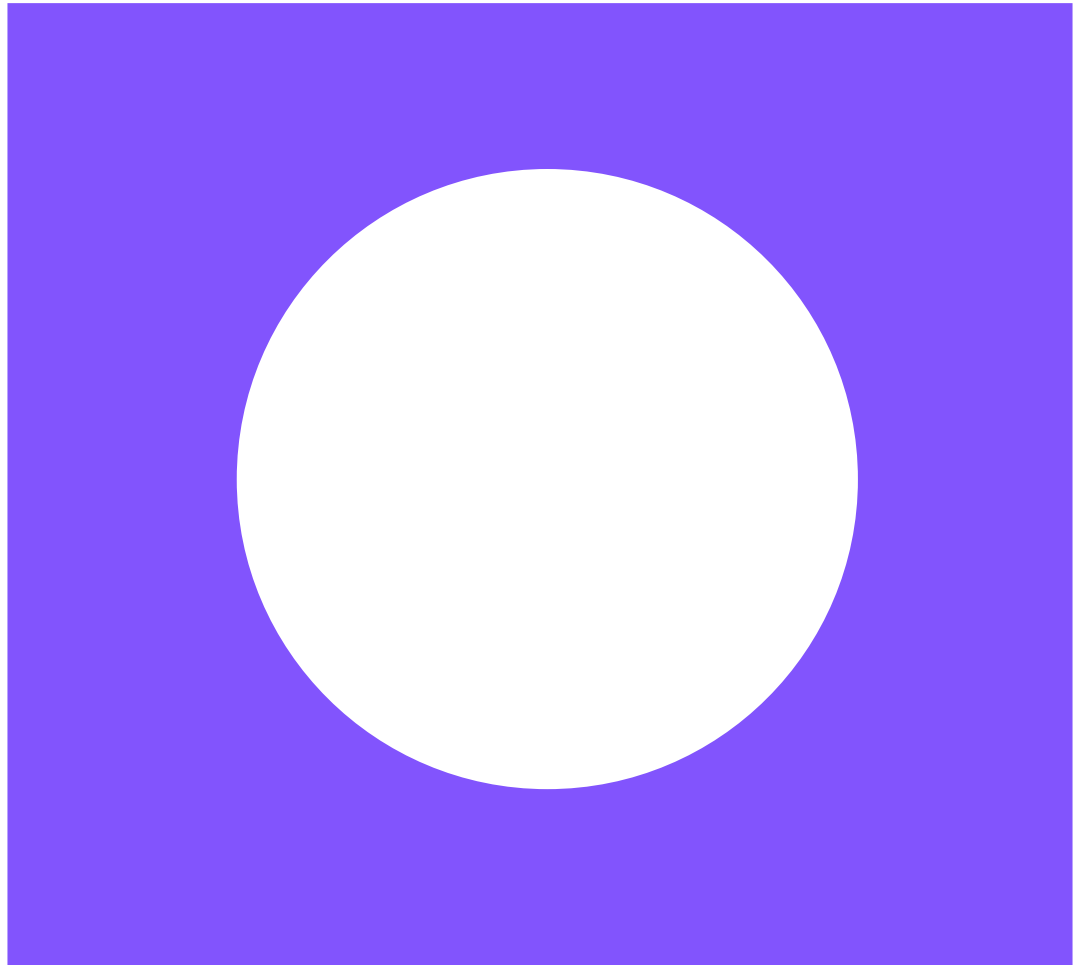
## 5 Quality Reporting Plan

The following Quality deliverables are defined. Frequency of submission and quality management content should be as defined in **Table 3: QC Activities** and the section of this document describing Quality Assurance and Quality Control.

- Vendor Quality Management Plan - This should be submitted by the vendor and contain all quality assurance and quality control processes and procedures that the vendor warrants will be undertaken during the project.
- Vendor Startup Report - This should be submitted by the vendor and contain a description of the startup and calibration process and quality information as defined in **Table 3: QC Activities** and the section of this document describing Quality Assurance and Quality Control.
- Interim/Final Data Submissions - The vendor may submit interim data at regular intervals, or a single submission after full collection and include quality information as defined in **Table 3: QC Activities** and the section of this document describing Quality Assurance and Quality Control.
- Vendor Exception Reports - The vendor will submit reports listing all data exceptions identified by the vendor at regular intervals or as a single submission after full collection as defined in **Table 3: QC Activities** and the section of this document describing Quality Assurance and Quality Control.
- Independent Quality Report - These reports will be submitted to the City of Raleigh project manager by a party independent of the vendor (either by City of Raleigh internally, or by a City of Raleigh appointed representative). This report should be submitted at regular intervals and include quality information as defined in **Table 3: QC Activities** and the section of this document describing Quality Assurance and Quality Control.

## Appendix VIII - City of Raleigh Data Dictionary





# **Pavement Data Dictionary for Pavement Data Collection**

City of Raleigh

September 2025

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# **Pavement Data Dictionary for Pavement Data Collection**

City of Raleigh

September 2025

# Issue and revision record

Revision	Date	Description
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## Document reference:

This document is issued for the party which commissioned it and for specific purposes connected with the pavement data collection project only. It should not be relied upon by any other party or used for any other purpose.

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# 1 Introduction

This Pavement Data Dictionary will identify all the data elements required for input into the pavement management system including distress types, severity levels and methods of measurement for automated road rating data collection for the City of Raleigh, NC.

This document should be read in conjunction with the City of Raleigh Data Quality Management Plan (DQMP). The objective for this Data Dictionary document, together with the DQMP, is to ensure that data being delivered to support the Pavement Management program and pavement condition reporting is repeatable across multiple data collection cycles and as independent as possible of specific vendors that are collecting the data on behalf of the City. Having accurate and repeatable data ensures that:

- Trends based on quality data are available over time for analysis and reporting.
- Inputs into the pavement management system are reliable and as accurate as possible.

This Data Dictionary assumes that data will be collected using the following methods and frequency:

- Automated survey equipment shall be used.
- Data collection for each cycle shall be completed in a single data collection year.

## 2 Data Collection Specifications

### 2.1 Distinction between Pavement Management Section & Data Collection Segment

A Data Collection Segment refers to a length of roadway, measured in the direction of travel, measuring between 5 and 7 feet. Data collection segment lengths of 1/1000<sup>th</sup> of a mile, and 2 m are both acceptable. Data collection segments should be marked for exclusion in the case of bridges, construction, lane deviations, railroads or wherever data may not be valid for any reason.

A Pavement Management Section is made up of a group of contiguous data collection segments with similar characteristics including but not limited to pavement type, width, and cross-section.

### 2.2 Data Elements for Data Collection

The data to be collected on each data collection segment will include the data elements listed in **Table 1: List of Data Elements**. The data shall be submitted in a .CSV file format with one row per data collection segment and data elements in **Table 1** below as columns. Data that is not submitted in this format will not be accepted and the vendor will be required to reprocess or recollect the data.

**Table 1: List of Data Elements**

Column	Data Item	Description	Units	Data Type (Format)
1	SECTION_ID	City's Unique ID	N.A.	Integer
2	YEAR	Year of Survey (Defined by the City)	N.A.	Integer (XXXX)
3	STREET	Street Name	N.A.	Text
4	STREET_TYPE	Street Type	N.A.	Text
5	BLOCK_NBR	City Block Identifier	N.A.	Integer
6	CURB_GUTTER	Number of Curbs	N.A.	Integer
7	SIDEWALK	Number of Sidewalks	N.A.	Integer
8	BEG_DESCRIPTION	Beginning point of section	N.A.	Text
9	END_DESCRIPTION	End point of section	N.A.	Text
10	SECTION_LENGTH	Section Length	feet	Number (*,2)
11	SECTION_WIDTH	Section Width	feet	Number (*,2)
12	LANES	Number of Lanes	N.A.	Integer
13	DISTANCE_FROM	Linear feet between the start of the data collection segment and a reference point chosen by the data collection team	feet	Number (*,2)
14	DISTANCE_TO	Linear feet between the end of the data collection segment and a reference point chosen by the data collection team	feet	Number (*,2)
15	BEGIN_LATITUDE	Latitude of the beginning of data collection segment	decimal degrees	Number (12,8)
16	BEGIN_LONGITUDE	Longitude of the beginning of data collection segment	decimal degrees	Number (12,8)
17	END_LATITUDE	Latitude of the end of data collection segment	decimal degrees	Number (12,8)

Column	Data Item	Description	Units	Data Type (Format)
18	END_LONGITUDE	Longitude of the end of data collection segment	decimal degrees	Number (12,8)
19	SEGMENT_LENGTH	Length of data collection segment (approximately 6 to 6.5 feet) or slab length for concrete pavement	feet	Number (*,2)
19	SEGMENT_WIDTH	Width of data collection segment (up to approx. 12 feet)	feet	Number (*,2)
20	SEGMENT_AREA	Area of data collection segment	square feet	Number (*,2)
21	SURVEY_DATE	Date that data was collected for the segment	date	MM/DD/YYYY
22	SURVEY_TIME	Approximate time of image capture	time stamp	HH24:MM:SS
23	VEHICLE_SURVEY	Data Collection Vendor Survey Vehicle ID	N.A.	Text
24	SPEED_MPH	Speed of vehicle during data collection	MPH	Number (10,2)
25	COLLECTION_DIRECTION	Data to be collected from BEG_DESCRIPTION to END_DESCRIPTION where possible.	N.A.	CHAR (1)
26	TEMPERATURE	Ambient temperature at time of collection	degrees Fahrenheit	Number (5,2)
27	TOT_CRK_LEN	Total length of cracking for data collection segment	feet	Number (*,2)
28	CRCK_WID_AVG	Weighted Average Width of Cracking	inches	Number (*,4)
29	CRKD	Crack Density	feet / square feet	Number (*,4)
30	CRKD_H	Crack Density of cracks having width > 0.25"	feet / square feet	Number (*,4)
31	CRKD_L	Crack Density of cracks having width <= 0.25"	feet / square feet	Number (*,4)
32	PSCM	Pavement Surface Cracking Metric = crack density x weighted crack width (in feet)	square feet / square feet	Number (*,2)

Column	Data Item	Description	Units	Data Type (Format)
33	IRI_LWP	Roughness - IRI (Left wheel path)	inches/mile	Number (*,2)
34	IRI_RWP	Roughness - IRI (Right wheel paths)		
35	RUT_LWP	Rutting (Left wheel path)	inches (measured to the nearest 0.01 inch)	Number (*,2)
36	RUT_RWP	Rutting (Right wheel path)		
37	POTHOLES	Area affected by potholes	square feet	Number (*,2)
38	CRKD_H_Z1	Crack density of cracks having widths $\geq 0.25$ " measured as crack length per unit area of data collection segment	feet / square feet	Number (*,4)
39	CRKD_L_Z1	Crack density of cracks having widths $< 0.25$ " measured as crack length per unit area of data collection segment	feet / square feet	Number (*,4)
40	CRK_LEN_Z1	Length of Cracking	feet	Number (*,2)
41	AREA_Z1	Area of Analysis	square feet	Number (*,2)
42	CRK_WID_Z1	Weighted Average Width of Cracking	inches	Number (*,4)
43	CRKD_Z1	Crack Density (Crack Length / Interval Area)	feet / square feet	Number (*,4)
44	PSCM_Z1	Pavement Surface Cracking Metric = crack density x weighted crack width (in feet)	square feet / square feet	Number (*,2)
45	CRKD_H_Z2	Crack density of cracks having widths $\geq 0.25$ " measured as crack length per unit area of data collection segment	feet / square feet	Number (*,4)
46	CRKD_L_Z2	Crack density of cracks having widths $< 0.25$ " measured as crack length per unit area of data collection segment	feet / square feet	Number (*,4)
47	CRK_LEN_Z2	Length of Cracking	feet	Number (*,2)
48	AREA_Z2	Area of Analysis	square feet	Number (*,2)
49	CRK_WID_Z2	Weighted Average Width of Cracking	inches	Number (*,4)

Column	Data Item	Description	Units	Data Type (Format)
50	CRKD_Z2	Crack Density (Crack Length / Interval Area)	feet / square feet	Number (*,4)
51	PSCM_Z2	Pavement Surface Cracking Metric = crack density x weighted crack width (in feet)	square feet / square feet	Number (*,2)
52	CRKD_H_Z3	Crack density of cracks having widths $\geq 0.25$ " measured as crack length per unit area of data collection segment	feet / square feet	Number (*,4)
53	CRKD_L_Z3	Crack density of cracks having widths $< 0.25$ " measured as crack length per unit area of data collection segment	feet / square feet	Number (*,4)
54	CRK_LEN_Z3	Length of Cracking	feet	Number (*,2)
55	AREA_Z3	Area of Analysis	square feet	Number (*,2)
56	CRK_WID_Z3	Weighted Average Width of Cracking	inches	Number (*,4)
57	CRKD_Z3	Crack Density (Crack Length / Interval Area)	feet / square feet	Number (*,4)
58	PSCM_Z3	Pavement Surface Cracking Metric = crack density x weighted crack width (in feet)	square feet / square feet	Number (*,2)
59	CRKD_H_Z4	Crack density of cracks having widths $\geq 0.25$ " measured as crack length per unit area of data collection segment	feet / square feet	Number (*,4)
60	CRKD_L_Z4	Crack density of cracks having widths $< 0.25$ " measured as crack length per unit area of data collection segment	feet / square feet	Number (*,4)
61	CRK_LEN_Z4	Length of Cracking	feet	Number (*,2)
62	AREA_Z4	Area of Analysis	square feet	Number (*,2)
63	CRK_WID_Z4	Weighted Average Width of Cracking	inches	Number (*,4)
64	CRKD_Z4	Crack Density (Crack Length / Interval Area)	feet / square feet	Number (*,4)

Column	Data Item	Description	Units	Data Type (Format)
65	PSCM_Z4	Pavement Surface Cracking Metric = crack density x weighted crack width (in feet)	square feet / square feet	Number (*,2)
66	CRKD_H_Z5	Crack density of cracks having widths $\geq 0.25$ " measured as crack length per unit area of data collection segment	feet / square feet	Number (*,4)
67	CRKD_L_Z5	Crack density of cracks having widths $< 0.25$ " measured as crack length per unit area of data collection segment	feet / square feet	Number (*,4)
68	CRK_LEN_Z5	Length of Cracking	feet	Number (*,2)
69	AREA_Z5	Area of Analysis	square feet	Number (*,2)
70	CRK_WID_Z5	Weighted Average Width of Cracking	inches	Number (*,4)
71	CRKD_Z5	Crack Density (Crack Length / Interval Area)	feet / square feet	Number (*,4)
72	PSCM_Z5	Pavement Surface Cracking Metric = crack density x weighted crack width (in feet)	square feet / square feet	Number (*,2)
73	COMMENTS	Used for reporting issues and exceptions by the Vendor	N.A.	Text

## 3 Specifications, Definitions and References

### 3.1 Data Collection Zones

The definition of the zones for cracking reporting are shown in **Figure 1 - Definition of Transverse Zones (Source: AASHTO R85-18)**.

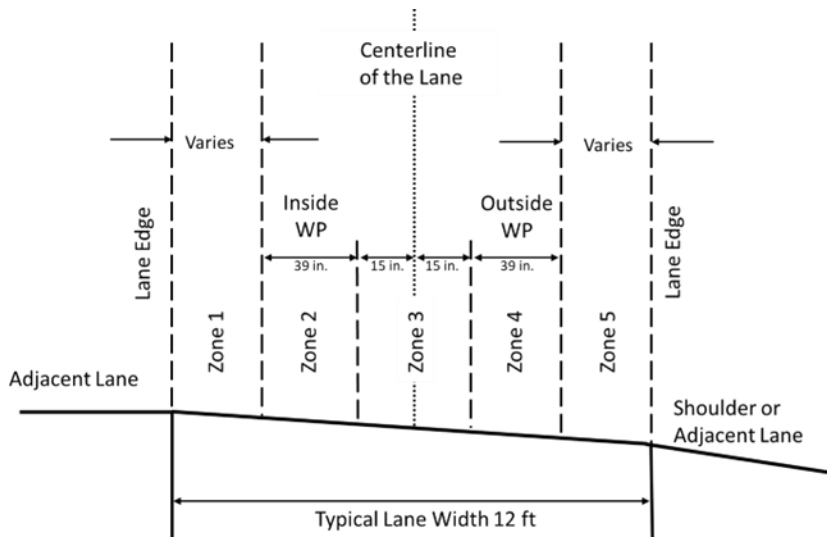
**Left Edge / Zone 1** – The area between the inside wheel path and the inside lane edge as defined by a lane marking, or the 6 feet to the left of the vehicle centerline in the direction of travel, whichever is most restrictive. (The term “inside edge” is synonymous.)

**Zone 2** – The inside wheel path.

**Zone 3** - The space between the wheel paths. (The term “central zone” is synonymous.)

**Zone 4** – The outside wheel path.

**Right Edge / Zone 5** – The area between the outside wheel path and the outside lane edge as defined by a lane marking or curb, or 6 feet to the right of the vehicle centerline in the direction of travel, whichever is most restrictive. (The term “outside edge” is synonymous.)

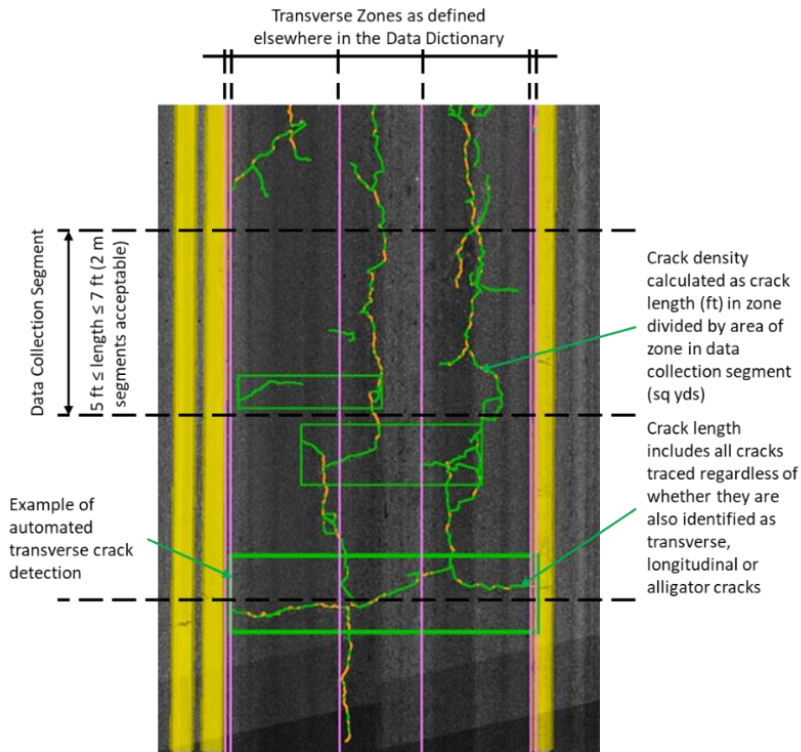


**Figure 1 - Definition of Transverse Zones (Source: AASHTO R85-18)**

### 3.2 Cracking Data

Cracking is defined as a fissure or discontinuity of the pavement surface not necessarily extending through the entire thickness of the pavement (HPMS Field Manual). Cracking data will be collected using LCMS II equipment or equivalent and processed to meet the

requirements of ASTM E3303 Standard, this data dictionary, and the City of Raleigh Data Quality Management Plan. **Figure 2 - Sample of cracking data collected from LCMS** of cracking data collected by the Laser Crack Measurement System.



**Figure 2 - Sample of cracking data collected from LCMS**

### 3.3 Definitions

**Cracking** – defined as a fissure or discontinuity of the pavement surface not necessarily extending through the entire thickness of the pavement.

**Crack Density** – is calculated within zones in data collection segments and aggregated at the management section level.

**Crack length** – The length measured along the crack path using all available data points between crack termini.

**Crack terminus** – The point at which a crack width goes below and remains less than 0.04 inches for 0.4 inches length, or the intersection with another crack, or the edge of a zone or data collection segment.

**Data Collection Zone** – one of the five strips of pavement created by the wheel paths and the areas between and outside the wheel paths. (The terms “road zone” and “measurement zone” are synonymous.)

**Data Collection Segment** – refers to a length of roadway, measured in the direction of travel, measuring between 5 and 7 feet. Data collection segment lengths of 1/1000th of a mile, and 2 meters are both acceptable.

**Pavement Management Section** – is made up of a group of contiguous data collection segments with similar characteristics including but not limited to pavement type, width, and cross-section.

**Pavement Surface Cracking Index (PSCI)** – a numerical, dimensionless rating of the pavement cracking that ranges from 0 to 100, with 0 being the worst possible condition and 100 being the best possible condition. (PSCI is a translation of the PSCM to a 0 to 100 scale.)

**Pavement Surface Cracking Metric (PSCM)** – a numerical, dimensionless measure of the pavement cracking defined as area of open fissures within the area being analyzed divided by the total area being analyzed. It is equivalent to crack density multiplied by weighted crack width. PSCM values will typically range from 0 for a road with no cracking to about 10 % for a road with heavy cracking. (PSCM is calculated from measurements of crack length, crack width, and pavement segment/section area.)

### 3.4 References

**ASTM E3303**, “Standard Practice for Generating Pavement Surface Cracking Indices from Digital Image,” 2021, ASTM International, 100 Barr Harbor Drive, PO Box C700, West Conshohocken, PA 19428-2959, Book of Standards Volume: 04.03, DOI: 10.1520/E3303-21, ICS Code: 93.080.01, [www.astm.org](http://www.astm.org)

**AASHTO R85**, “Standard Practice for Quantifying Cracks in Asphalt Pavement Surfaces from Collected Pavement Images Utilizing Automated Methods,” 2018, American Association of State Highway and Transportation Officials (AASHTO), (Standard No. R85), [www.transportation.org](http://www.transportation.org)

**AASHTO R43**, American Association of State Highway and Transportation Officials (AASHTO), 2013, “Standard Practice for Quantifying Roughness of Pavements,” (Standard No. R43), [www.transportation.org](http://www.transportation.org)

**AASHTO R87**, American Association of State Highway and Transportation Officials (AASHTO), 2018, “Standard Practice for Determining Pavement Deformation Parameters and Cross Slope from Collected Transverse Profiles,” (Standard No. R87), [www.transportation.org](http://www.transportation.org)

**AASHTO R88**, American Association of State Highway and Transportation Officials (AASHTO), 2018, “Standard Practice for Collecting the Transverse Pavement Profile,” (Standard No. R88), [www.transportation.org](http://www.transportation.org)

**Highway Performance Monitoring System Field Manual**, 2016, U.S. Department of Transportation, Federal Highway Administration, Office of Highway Policy Information, [www.fhwa.dot.gov](http://www.fhwa.dot.gov)

